City of Norfolk, Virginia
Department of Utilities

SUPPLEMENTAL SPECIFICATIONS

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City of Norfolk, Virginia
Department of Utilities

INTRODUCTION TO SUPPLEMENTAL SPECIFICATIONS

The following Supplemental Specifications are intended to be used in conjunction with the Hampton Roads Planning District Commission (HRPDC) Regional Standards, 3rd Edition. Unlike the HRPDC standards that are general to most water and wastewater projects, these Supplemental Specifications are specific and must be tailored to each individual project. The Design Engineer must carefully review these specifications and make the necessary modifications for each specific project. In general, anywhere there are parentheses or a blank line the Design Engineer shall include the necessary project specific information.

These specifications are to be used as a guide that will provide conformity to the design and review of public water and wastewater utility improvements that are to be owned and maintained by the City of Norfolk. As it is very difficult to generalize engineering design matters without endangering the final product, consultants and developers shall design projects using theses specifications presented herein as a guide only. These Supplemental Specifications are not intended to replace sound engineering judgment. Design Engineers should consider the applicability of the contents of these documents to specific projects and, based on the characteristics and requirements of the projects, make adjustments accordingly. Deviations from these specifications require prior approved by the Department.

THE CITY OF NORFOLK MODIFICATIONS TO HRPDC REGIONAL STANDARDS, 3rd Edition				
Annual Construction Contract for Gravity Sewer System Replacement, Norfolk, VA				
Section	**Sub-Section**	**Name**	**Add/ Delete**	**Modification**
All Sections		Measurement for Payment.	Replace	See Section 110 for City of Norfolk Department of Utilities Payment Item Descriptions.
		Submittals	Consider adding	Paragraph A of every section requests a construction schedule for approval. Consider adding "Approval of the schedule shall not constitute a representation by the Owner that the work can be completed as shown on the schedule."
200	II.2.1	Quality Assurance	Modify	Change The VDOT Road and Bridge Specifications edition date from 1994 to 2002.
	II.2.2	Quality Assurance	Add	International Plumbing Code Norfolk Arboricultural Specifications and Standard Practice Manual
	III.3.6	Submittals	Add	Add the following sentences: “The Contractor shall also certify that this substitution will not adversely affect other elements of the Work or the construction schedule, and shall identify local maintenance service and source(s) of replacement parts and materials. Requests for substitutions shall be submitted at the pre-construction meeting and must be approved in writing by the Engineer prior to the start of any construction.”
	IV.4.3.B	Aggregate	Modify	Correct the sentence to read, “Aggregates placed directly on the ground for stockpiling purposes, shall not be removed from those stockpiles within 1 foot of the ground until final cleanup. (Only clean aggregate shall be used.)
	V.5.1.E	Aggregate	Add	Insert “of this document” after “Division 8 activities” and before the comma.
	V.5.10.A.9	Ductile Iron Pipe	Add	Ductile Iron pipe shall have Sewpercoat calcium aluminate lining, Protecto 401 ceramic epoxy lining, or equal hydrogen sulfide resistant lining approved by the Department.
	V.5.10.A.9	Ductile Iron Pipe	Delete	"or, a polyurethane lining of 35 mils minimum thickness."
	V.10.B.5	PVC Pipe	Modify	Correct the second sentence to read: “When Compact fittings are used, they shall have a minimum acceptable pressure rating of 350 psi.”
	V.10.B.7.	PVC Pipe	Modify	Correct the sentence to read: “Solvent cement for non-gasketed PVC pipe shall meet the requirement of ASTM D-2564.”
	V. 5.10.C.	HDPE Pipe	Delete	Strike out section
	V.5.10.D.1.a.	Valves	Add	“All gate valves for sewer shall open left (counterclockwise).
	V.5.10.D.1.c.	Valves	Delete	Delete “with threaded connections” from the first sentence.
	V.5.10.D.1.d.	Valves	Add	Accessories: Provide zinc plated bonnet bolts, studs and nuts for unsubmerged service. Provide stainless bonnet bolts, studs and nuts for submerged service. Make wedging devices bronze to iron or bronze to bronze. Provide glands which are bronze or bronze bushed and bronze gland bolts and nuts.
	V.5.10.D.3	Valve Operators	Delete	“A valve key wrench of adequate length and of each type required shall be provided for each project.”
	V.5.10.D.4.	Valve Stem Extensions	Delete	Strike out section

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		Check Valve	Add	Provide single disc swing check valves designed to allow a full diameter passage and to operate with a minimum loss of pressure. Provide 1/8 through 3 inch check valves that meet the requirements of MSS SP-80. Provide 4 inch through 24 inch check valves that meet the requirements of AWWA C508. Equip check valves with bronze renewable seat rings, bronze discs or disc rings and bronze disc hinge bushings and pins. Carefully mount discs and provide discs that swivel in disc hinges. Provide pins, discs and other parts that are noncorrosive, nonsticking and properly cured to operate satisfactorily within a temperature range of 34 to 100 degrees Fahrenheit and with the fluids specified. Equip 6 inch and larger check valves with outside levers and weights. Provide check valves manufactured by American Flow Control, Clow Valve, M&H Valve, Mueller Valve, or approved equal.
	V.5.10.F.2.a.	Joint Restraint Devices	Modify	Re-title the section “Pipe Restraint:”
	V.5.10.F.2.c.	Joint Restraint Devices	Add	Harnessing: For ductile-iron pipe and fittings with mechanical joints that require harnessing, provide ductile-iron mechanical joint retainer glands.
	V.5.10.F.3.c.	Joint Restraint Devices	Add	Harnessing: For PVC joints requiring harnessing, provide Series 1300/1390 restraining fittings as manufactured by Uni-flange, Corp., Series 1110 HV and Series 2000 PV as manufactured by EBAA Iron Sales, Inc., or equal
	V.5.11.A.6	Ductile Iron Pipe Fittings	Modify	Correct the second sentence to read: “When Compact fittings are used, they shall have a minimum acceptable pressure rating of 350 psi.”
	V.5.11.A.8	Ductile Iron Pipe Fittings	Add	After ANSI/AWWA add “Current Department approved linings include Sewpercoat calcium aluminate lining and Protecto 401ceramic epoxy lining. Other hydrogen sulfide resistant linings shall be submitted for review and approval as equal”.
	V.5.11.B.5.	PVC Pipe	Delete	"SDR 23.5 or"
	V.5.11.B.8	PVC Pipe Fittings	Add	Add paragraph “For Mains installed, where cover is 10’ (ten feet) or greater, the pipe shall be C900 DR 18 or Ductile Iron.”
	V.5.11.B.9	PVC Pipe Fittings	Add	Add paragraph “All fittings shall be molded or ductile iron. No fabricated fittings will be allowed.”
	V.5.11.C.	ABS or PVC Composite Pipe and Fittings	Delete	Strike out section
	V.5.11.D.5	Manholes	Delete	Last sentence starting with, "Aluminum steps…".
	V.5.19.A.6	Ductile Iron Pipe Fittings	Modify	Correct the second sentence to read: “When Compact fittings are used, they shall have a minimum acceptable pressure rating of 350 psi.”
	V.5.19.B.3.	PVC Pipe	Delete	“couplings, and fabricated fittings” and “or fitting”.
	V.5.19.B.7.	PVC Pipe	Delete	Strike out paragraph
	V.5.19.B.7.	PVC Pipe	Modify	Where Schedule 80 PVC is used, solvent cement shall meet the requirement of ASTM D-2564.
	V.5.19.C.	Copper Water Pipe	Delete	Strike the sentence that starts, “Fittings shall be wrought…”

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	V.5.19.D.1.b.	Valves	Add	All gate valves for water shall open right (clockwise).
	V.5.19.D.1.c.	Valves	Delete	Strike out “with threaded connections”.
	V.5.19.D.2.a	Butterfly Valves	Modify	Replace “16 inches” with “20 inches”.
	V.5.19.D.4.	Valve Operators	Modify	Strike out the sentence that begins, “A valve key wrench…” Add the following: “NOTE: Water valves open right (clockwise).”
	V.5.19.D.5.	Valve Stem Extensions	Delete	Strike out paragraph
	V.5.19.F.1	Fire Hydrants	Add	“All fire hydrants shall be manufactured in complete accordance with American Water Works Association Specification C502, latest revised edition, and shall be as manufactured by the Darling Valve & Manufacturing Company (Model B-50-B), Mueller Centurion A-421, Pacer Model W-67, Kennedy K-81, or approved equal. Hydrants shall have full 360o revolving heads and shall open by turning the operating nut to the right (clockwise).
	V.5.19.F.2	Fire Hydrants	Delete	“The fire hydrant shall be painted with a high gloss, alkalyd industrial enamel (colors to be selected by the Owner)”.
	V.5.19.F.3	Fire Hydrants	Delete	Strike out paragraph
	V.5.19.F.5	Fire Hydrants	Modify	Change the the section on steamer nozzles from, "…nozzle with 4-inch (or 4 1/2-inch as specified by the Owner) National…" to, "…nozzle with 4 1/2-inch National…".
	V.5.19.F.6	Fire Hydrants	Delete	Strike out paragraph.
	V.5.19.H.1	Water Meters	Delete	“meter yoke”.
	V.5.19.H.2	Water Meters	Delete	“and installed”
	V.5.19.I.4.a	Concrete Reaction Blocking	Add	The phrase, ", or as designated by the Engineer," after the word, "Drawings".
	V.5.19.I.	Concrete Reaction Blocking	Delete	subsections b, and c.
	V.5.19.J.2.	Tapping Valves and Sleeves	Delete	Strike out the sentence, “The valves shall be subjected to a test…”
	V.5.19.J.3.a.	Tapping Sleeves for DI Pipe and PVC C-900	Modify	In the first sentence insert “full bodied” between “shall be” and “mechanical joint”. Delete “in accordance with ANSI/AWWA C110/A21.10. and” from the sentence beginning with “Tapping sleeves shall be…”
	V.5.19.J.3.b.	PVC pipe (Other than C-900)	Delete	Strike out the first paragraph, which begins, “Tapping sleeves shall be complete…”
	V.5.20.B.	Subsurface Utility Warning Tape	Modify	Replace “metalized” with “non-metallic”.

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	V.5.21.F.1	Manhole Rehabilitation using Cementious Products	Delete	Delete entire section
	V.5.21.I.2	Manhole Frame Seals	Delete	After "only be installed with the" delete "cementious lining and"
303	II.2.2.B.5	Trenching, Backfilling, and Compaction	Modify	Re-write the last sentence to read ”In such instances, sheeting will be cut off at least two (2) feet below finished grade and left in place.”
	II.2.2.E.1	Trench Bedding and Backfilling	Modify	Replace “Contractor” with “Inspector”.
	II.2.2.E.4.	Trench Bedding and Backfilling	Modify	Replace the paragraph with: “Backfill material shall be solidly compacted around the pipe in 6” layers up to sub-base of the roadway or the existing ground elevation. As a minimum, compact each layer of the backfill material to 95% maximum density as determined in accordance with VTM-1.
	II.2.2.E.7.	Trench Bedding and Backfilling	Modify	Replace in the first sentence, "...material to not less than the following percentages at the maximum…" with "…material to 95% maximum…".
	II.2.2.E.7.	Trench Bedding and Backfilling	Delete	sub sections “a – c”.
	II.2.2.E.7.d.		Add	“The City may, at any time, require compaction testing to ensure compliance with the specifications. A recognized testing laboratory that is selected by the City will conduct all tests. The testing laboratory is to be qualified in the field of the materials to be tested. If applicable, all tests will be conducted in accordance with V.D.O.T.’S “Manual for Virginia Testing Methods” (Current Edition, as Revised). Payment for all tests will be in accordance with the following: A) The cost of all tests failing to meet the minimum requirements will be borne by the Contractor. B) The costs of all tests that either meet or exceed the minimum requirements shall be borne by the City.
	II.2.2.F.	Restoration - General	Delete	“in accordance with the drawings and at a minimum the areas disturmed shall be”. Leave the remainder of the sentence.
	II.2.2.G.2.	Pavement Removal for Placement of Pipelines	Modify	Replace the sentence beginning, “The minimum requirements for a…” with, “Temporary pavement shall be of minimum 6” stone with 3” of cold mix laid to the original line and grade and thoroughly compacted.”
	II.2.3.	Tolerances	Delete	Complete Section
	Section III.	Measurement for Payment.	Replace	See Section 110 for City of Norfolk Department of Utilities Payment Item Descriptions.

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801	II.2.2.C.7.	Pipe Installation	Modify	Replace "300" with "100"
	II.2.2.F.	Tracer Wire	Modify	Replace "attached every 10 feet to" with "1 foot above".
	II.2.2.G.	Subsurface Utility Tape	Modify	Re-write the paragraph to read," All non-metallic water mains shall be identified by a subsurface non-metallic utility warning tape placed at an elevation of 12" above the copper tracer wire or as directed by the owner, conforming to Section 200."
	II.2.3.A.	Valve Installation	Modify	After "direction of openings" insert the following, "(All water valves open right)". Re-write the second sentence to read, "Valves found not opening to the right, or determined to be defective by the Owner shall be rejected, removed from the site, and replaced by the Contractor at no additional cost to the Owner."
	II.2.6.C.	Restraint	Add	After "…coating" add the following, "or as directed by the Owner."
	II.2.7.B.	Connections to Existing Mains	Delete	Delete the sentence that begins with, "Connection shall be…". Delete the last two sentences and replace with, "The Owner shall make every effort to have a complete shut down. Failure by the owner to achieve a complete shut down shall not entitle the Contractor to any additional compensation."
	II.2.7.B.4	Connections to Existing Mains	Modify	Replace the paragraph with, "Tie-ins to existing mains shall only be performed after the new main has been satisfactorily pressure tested and chlorinated. The contractor may not tie-in the new main to the existing main until after the results of the bacteriological tests have been completed and approved by the owner."
	II.2.7.C.	Tapping Existing Mains Under Pressure	Delete	Delete subsections 2, 3, and 5.
	II.2.7.C.4.	Tapping Existing Mains Under Pressure	Modify	Change the pressure to 150 psig and maintain the pressure for 1-hour.
	II.2.7.C.6.	Tapping Existing Mains Under Pressure	Add	In the first sentence, after "…branch are acceptable" add the following, "unless otherwise directed by the owner."
	II.2.8.B.1.	Pressure Test	Modify	In the sentence which begins, "Water mains shall be…" remove the portion that states, "1.5 times the expected working pressure or" and the portion that states, "whichever is greater". In the sentence which begins, "The pressure test shall be…" after "that are discovered", insert, "during and". After "…replaced by the Contractor" insert "and retested."
	II.2.8.B.3.	Pressure Test	Add	", or as directed by the Owner."
	II.2.8.B.8.	Pressure Test	Modify	Replace this subsection with, "The test pressure shall be maintained at the pressure stated in the project specifications throughout the duration of the test period. The water used to maintain the test pressure shall be measured and shall be less than the allowable leakage in order for the main to have passed the test."
	II.2.8.B.8.	Pressure Test	Modify	Recommend leaving section as written. The modification is redundant with the next paragraph.
	II.2.8.B.10.	Pressure Test	Modify	After "…restraint and support" insert " for testing apparatus".
	II.2.8.B.10.	Pressure Test	Modify	Recommend leaving section as written. Temporary plugs, valves, etc. would need to be supported.
	II.2.8.C.2.	Leakage Test	Modify	Insert the word "excess" between "…until the" and "leakage is eliminated."

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802	II.2.2.C.6.	Pipe Laying	Modify	After "…shall be closed" insert "by use of a temporary bulkhead" and delete "to the satisfaction of the Owner"
	III.3.2	Measurement of Quantities	Delete	See Measurement and Payment items in attached appendix.
	III.3.3	Pay Items	Delete	See Measurement and Payment items in attached appendix. (Note: 3.3.B - 90% payment before testing is too high - does not give much incentive to complete the project if there are significant repairs to be made.)
803	II.2.2.E	Tracer Wire	Modify	Replace “attached every 10 feet to” with “1 foot above”.
	II.2.2.F	Subsurface Utility Tape	Modify	Re-write the paragraph to read,” All non-metallic water mains shall be identified by a subsurface non-metallic utility warning tape placed at an elevation of 12” above the copper tracer wire or as directed by the owner, conforming to Section 200.”
	II.2.3.A	Valve Installation	Modify	After “direction of openings” insert the following, “(All sanitary sewer valves open left)”. Re-write the second sentence to read, ”Valves found not opening to the left, or determined to be defective by the Owner shall be rejected, removed from the site, and replaced by the Contractor at no additional cost to the Owner.”
	III.3.3.B	Pay Items	Delete	90% payment before testing is too high - does not give much incentive to complete the project if there are significant repairs to be made.
804	II.2.2.C.3	Jacking	Add	The thrust wall and jacking system shall be designed to carry the thrust of the jacks to the soil without excessive soil deflection and in such a manner as to avoid any disturbance of adjacent structures or utilities.
	II.2.2.E.4	Carrier Pipe Installation	Add	The carrier pipe shall be electrically isolated from the casing pipe.
805	I.1.2.B.2	Unusual Conditions	Modify	Replace the second half of the sentence that begins, “pressure tested in place…” and ends “…and tested in place.” with, “, and meets current Virginia Department of Health Sewage Collection and Treatment Regulations.”
810	II.2.1.D	General	Consider adding	A television inspection shall be completed after cleaning to verify that the cleaning operation was successful. The television inspection shall be in accordance with Section 811 - Television Inspection.
	II.2.2.F	Acceptance of Cleaning Operation	Recommend Modifying	After "Acceptance of sewer line cleaning…" delete the remaining sentence and add "shall be deemed sufficient after Owner review and approval of the post cleaning videotape."
	III.3.1.A	Pay Items	Recommend Adding	After "debris removed are submitted" add "and post-cleaning TV Inspection tape has been reviewed and approved by the Owner."
822				Replace entire section with Supplemental Specification for Manhole and Wet Well Rehabilitation and Coating.

MANUALLY CLEANED BAR SCREENS

1. GENERAL

1.1 DESCRIPTION OF WORK

A. This section includes the requirements for furnishing and installing (____) manually cleaned bar screen(s) and furnishing bar rake(s) as specified or required for a complete installation. Locate the screens as shown on the Contract Drawings.

B. Codes and standards referred to in this section are:

1. ASTM A 276 - Specification for Stainless and Heat Resisting Steel Bars and Shapes

2. ASTM A 36/A36M - Specification for Carbon Structural Steel

1.2 SUBMITTALS

Submit working drawings including arrangement and erection drawings of the equipment.

2. PRODUCTS

2.1 BAR SCREENS

A. Provide bar racks consisting of (3/8- by 3-inch rectangular structural steel bars conforming to ASTM A 36/A36M) (3/8- by 2-1/2-inch rectangular 304 stainless steel bars conforming to ASTM A 276) fastened top and bottom to provide the clear spacing between the bars as shown. Provide bars which are straight and firmly anchor them to the channel floor and at the top. Provide stainless steel anchors, bolts and nuts as shown.

2.2 CLEANING RAKES

A. Provide cleaning rakes constructed of heavy 304 stainless plate conforming to ASTM A 276 of the dimensions as shown. Provide cleaning teeth with a minimum penetration of 2 inches in the bar screen spacing. Provide a (__) foot long aluminum handle made of 1-1/4-inch Schedule 40 aluminum pipe. The weight of the rake shall not exceed 15 pounds.

3. EXECUTION

3.1 INSTALLATION

Install bar racks as shown in the channel at the indicated angle of inclination. Countersink bolts or flat head screws used for attachment at the top for a flush finish.

END OF SECTION

DRY PIT SUBMERSIBLE SEWAGE PUMPS

1. GENERAL

1.1 DESCRIPTION OF WORK

A. This section includes the requirements for furnishing and installing submersible sewage pumping units, and all appurtenances necessary for a complete installation. Locate the submersible sewage pumping units as shown in the dry pit.

B. Codes and standards referred to in this section are:

1. ASTM A 48 - Specification for Grey Iron Castings

2. Hydraulic Institute Standards

3. IEEE 82 - Test Procedure for Impulse Voltage Tests on Insulated Conductors

4. NEC - National Electric Code

5. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

6. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. Provide pumps of the vertical, centrifugal, heavy duty, non-clog, close-coupled, submersible type driven by an electric motor. Provide motors suitable for dry-pit and submersible pump operation and mounted as an integral part of the pump. Design the pumping units to pump raw wastewater. Arrange the pumping equipment in the spaces shown on the Contract Drawings and in accordance with approved shop drawings.

D. Provide pumps to operate at the capacities and heads and over the range of operating conditions specified without overloading, cavitation, undue noise or vibration. Pumps shall be capable of full reverse rotational speed with no damage occurring to the motor or pump. Furnish the pumps in accordance with the following requirements:

Items	Requirements	
	Unit 1	Unit X
Capacity at rating point, gpm	_____	_____
Total head at rating point, feet	_____	_____

Items	Requirements	
	Unit 1	Unit X
Overall efficiency, wire to water, at rating point, minimum, percent	_____	_____
Shutoff head, feet		
Maximum	_____	_____
Minimum	_____	_____
Capacity at secondary rating point, minimum, gpm	_____	_____
Total head at secondary rating point, feet	_____	_____
Overall efficiency, wire to water, at secondary head, minimum, percent	_____	_____
Capacity at reduced speed rating point, gpm	_____	_____
Total head at reduced speed rating point, feet	_____	_____
Diameter of sphere that will pass through pump, minimum, inches	_____	_____
Pump discharge diameter, minimum, inches	_____	_____
Pump speed, maximum, rpm	_____	_____
Low water elevation for continuous operation, feet	_____	_____
Wet well floor elevation, feet	_____	_____
Motor horsepower, hp		
Minimum	_____	_____
Maximum	_____	_____
Motor efficiency at full load, minimum, percent	_____	_____
Motor power factor at full load, minimum, percent	_____	_____
Locked rotor kVa/hp, maximum, (Motor) (NEMA) code letter	_____	_____

E. Design each pump to have a continuously rising characteristic curve from the rating point to shutoff which passes through the rating point, and which meets or exceeds the specified heads and capacities, all within the Hydraulic Institute tolerances.

F. Provide pumping units capable of sustaining full reverse runaway speed without damage.

G. Furnish pumping units that do not exceed 0.35 inches per second peak velocity filtered vibration when operating over the range of specified conditions.

1.2 SUBMITTALS

Submittals shall be made by the Contractor in accordance with the procedures set forth in Section 105 – Control of Work, and as described below. The Contractor shall submit the following information for review and approval.

A. Certificates

Provide a certificate of compliance and compatibility from the submersible sewage pump manufacturer-supplier for the pumps, motors and adjustable frequency drives.

B. Drawings

Contractor's Drawings.

Submit working drawings, including arrangement and erection drawings of the equipment and equipment operating characteristics. Include the following:

a. Pump performance curves. Draw the curves for the specified conditions including those at reduced speed. Include head, input kilowatts, required NPSH, and overall efficiency, as a function of capacity from zero to maximum capacity.

b. General arrangement drawing of pumping unit and support system. Include equipment weight and anchor methods and materials.

c. Cross section drawing of pumping unit.

C. Data

Pump information

a. Parts list with materials of construction identified.
b. Motor performance characteristics.
c. Spare parts list.
d. Painting procedure.

D. Reports

Submit the following test reports:

a. Shop test procedures.
b. Six (6) certified copies of the Shop Test results for the pumping units.
c. Six (6) certified copies of the Manufacturer's Field Test Reports.

E. Statements

Pump unit qualification report as specified in paragraph 1.3 Quality Assurance.

F. Instructions

Submit the Operation and Maintenance manuals for the pumping equipment.

1.3 QUALITY ASSURANCE

Provide pumping equipment produced by a manufacturer who has regularly engaged in the design, manufacture, assembly and production of submersible sewage pumping equipment of the size and application as specified for not less than the last five years. In addition, the manufacturer shall submit a report documenting successful operation of three or more facilities within the USA of at least equal horsepower and speed that are similar in design and function to those being furnished for this contract; applicable to pumps in excess of 150 horsepower only. Each facility shall have units which have been operated a minimum of 10,000 hours over five years. Provide the names and telephone numbers of the users within the documentation report for verification. Failure to submit the report with adequate documentation will be cause for rejection of the pumping equipment.

1.4 SPARE PARTS

A. Provide the following spare parts for each size and type of pump:

1. One set of cable entry grommets
2. One set of "O"-rings
3. Two spare seals
4. One spare Impeller
5. Touch Up Paint

B. Furnish a complete set of special wrenches, spanners, eye bolts and other special tools sufficient to completely dismantle and reassemble each kind and size of pumping unit. Provide tools of forged steel, case hardened, and full

finished. Furnish the sets with a metal tool case with a handle and provision for padlocking.

1.5 SERVICE

The pump manufacturer shall have a local authorized factory service center located within 300 miles of the project site capable of completely servicing the proposed pumps. This facility must routinely stock spare parts (mechanical seals, bearings, O-rings, etc.) on the shelf. The service facility must be established and factory recognized for at least three years prior to bid. In addition, the pump manufacturer shall have a direct factory service center/stocking facility capable of completely servicing and providing spare parts within 24 hours for the proposed pumps within 800 miles of the project site.

1.6 WARRANTY

The pump manufacturer shall warranty the units supplied to the Owner, in writing, against defects in material and workmanship for a period of at least five years or 10,000 operating hours under normal use, operation, and service for the operating conditions presented by this project. The warranty shall cover parts and labor and shall be in printed form and apply to all units. Products repaired or replaced under warranty will be returned freight prepaid by pump manufacturer.

2. PRODUCTS

2.1 GENERAL CONSTRUCTION

A. Provide stainless steel fasteners, bolts, nuts and washers where exposed to the pumped liquid.

B. Provide machined metal-to-metal joints on component parts that are assembled together. Fit with an "O" ring seal where watertight joints are required. Do not use flat gaskets or sealing compounds to obtain watertight joints. Furnish machined rabbet fits on component joints as required to provide automatic alignment of rotating parts.

C. Provide eye bolts or lugs for lifting and handling the equipment. Provide suitable feet with anchor bolts for each pump. Design the feet for the pump to support the entire weight of the equipment of the foundation, without strain on the suction or discharge flanges.

D. Provide flanged suction and discharge connections with drilling and dimensions meeting the requirements of ANSIB16.1, Class 125.

E. Provide each pump with two (2) corrosion resistant metal name plates that indicate the pump serial number and rated capacity, head, speed, horsepower, voltage, and full load amps. Mount nameplates on the pumps and their AFD or MCC.

2.2 CASING

A. Provide pump casing of the centrifugal single volute with integral suction and discharge nozzle arranged for centerline discharge. Do not use diffusion vanes. Furnish smooth water passages that are able to withstand the abrasive action of solids.

B. Provide handholes with covers of ample size to permit inspection and cleaning of impeller and wear rings. Locate one handhole in the suction fittings or elbow ahead of the impeller. Provide each cover with its inside surface contoured to match the adjacent surfaces.

C. Construct pump casing of ASTM A48 cast iron, Class 35B.

D. Construct renewable wear rings of stainless steel.

E. Provide pump sized to fit within the allotted space as shown on the plans.

2.3 IMPELLER

A. Design impeller of the enclosed nonclog type. Provide pump-out vanes or a back ring, arranged with minimum clearances so as to preclude solids and stringy material from damaging the mechanical seal, on the back of the impeller.

B. Construct the impeller of ASTM A48 cast iron, Class 35B.

C. Provide impellers that are statically and dynamically balanced.

D. Provide impellers with a renewable Series 329 stainless steel wear ring with a minimum 350 BHN.

E. Secure the impeller to the shaft with a stainless steel key and lock nut in such a way that it cannot unscrew or become loosened due to rotation in either direction. Cover locknut for protection from the pumped fluid.

2.4 OIL CHAMBER

A. Provide an oil chamber to function as a buffer between the pumped liquid in the casing and the motor. Arrange the oil chamber to accommodate thermal

expansion of the oil. Furnish an oil chamber drain plug that is accessible from outside the pump unit and permits changing oil without dismantling pump components.

B. Construct the oil chamber of the same material as the pump casing.

C. Provide the oil chamber with a moisture sensor to initiate an alarm upon contamination of the oil by the pumped liquid.

2.5 MECHANICAL SEAL

Provide each pump with double or tandem mechanical seals. Design the upper seal unit, between the oil chamber and motor housing, with one stationary tungsten-carbide ring and one positively driven rotating tungsten-carbide ring. Provide the lower seal unit, between the pump casing and oil chamber, with one stationary ring and one positively driven rotating ring. Furnish rings made of tungsten-carbide. Use stainless steel for metal parts. Protect the spring element of the lower seal from solids contained in the pumped liquid. Do not rely upon the pumped liquid for lubrication. No seal damage is to result from operating the pumping unit dry. Seals must be capable of rotation in either direction without damage.

2.6 MOTOR

A. Provide submersible pump motor of 460-volt, 3-phase, 60-hertz. Motors shall be of the dry pit type designed for continuous duty, submerged or unsubmerged.

B. Ratings:

Voltage/phase/cycles	460/3/60
NEMA design type	B
NEMA code letter	J
Maximum rated full load current	
XXX HP:	XXX amperes
XXX HP:	XXX amperes
Minimum rated power factor at full load	85 percent
Minimum rated efficiency	90 percent

C. Design the motor to have suitable output torque and speed characteristic to start and operate the pump over the range of specified conditions without exceeding the nameplate rating. Base the nameplate horsepower rating on an 80 degrees C temperature rise above an ambient temperature of 40 degrees C when

operating with the AFD. Design the motor for continuous on-off cycling of ten starts per hour minimum without exceeding the 80 degree C temperature rise.

D. Provide the motor with a minimum of NEMA Class F (155 degrees C) moisture resistant insulation. Construct stator coils with NEMA Class H (180 degrees C) insulated winding wire. Apply impregnation resin to stator assembly in three dip and bake steps.

E. Provide each motor with three RTDs, one per phase, to protect against overheating. Provide the thrust bearing with RTD to protect against overheating. Use three conductor, compensated type RTD rated 100 ohms at 0 degrees C. The RTDs shall be monitored by the motor protection monitoring system.

F. Provide the motor with an ASTM A48 cast iron stator housing. For motors that employ cooling water jackets, design the water jacket passages to preclude clogging by solids contained in the pumped liquid. Provision for external cooling shall be provided. Provide the coolant passages with a vent arranged to allow escape of any air entrained into the pump. The cooling system shall provide sufficient cooling such that the motor can run under full load and at reduced speed in a totally unsubmerged condition.

G. Provide the motor cable entry with a mechanical locking ring or compression type cord grip to protect the cable jacket from being pulled out of the motor. Do not use epoxy for this purpose. Arrange the cable entry so as to provide a watertight seal. Isolate the cable entry leads from the internal motor leads to prevent entry of water into the motor chamber by leakage or wicking. Provide cables suitable for submersible pump application and conforming to NEC specifications for cable sizing. Provide sufficient cable to run from the power terminal box and control terminal box to the pumps.

H. Shaft

1. Provide a one piece, fully machined pump and motor shaft. Design the shaft to limit shaft deflection under maximum pumping load to .002 inches at the lower mechanical seal face and to obtain a rotating assembly first critical speed of not less than 150 percent of the rated speed.

2. Provide shafts of either carbon steel or stainless steel. Protect carbon steel shafts from exposure to the pumped liquid by employing a stainless steel sleeve or chrome plating.

I. Bearings

1. Provide two antifriction bearing assemblies. Design one assembly to carry only radial loads and to be free to float axially within the frame. Design the other assembly to carry both radial and axial loads and to be restrained from axial movement.

2. Select bearings in accordance with AFBMA 9 and 11 Load Ratings and Fatigue Life for Ball and Roller Bearings, to have a 100,000 hours minimum L_{10} bearing life at maximum pumping load that occurs under the specified operating conditions.

2.7 PROTECTION MONITORING SYSTEM

A. Provide each pumping unit with a monitoring system to protect critical machine functions during operation. (Design Engineer to specify critical machine functions.)

B. Initiate alarm and motor shutdown upon sensing moisture in the oil chamber.

C. Provide a monitoring device or devices to detect moisture. Design to be compatible with the sensors and motor controls. Locate monitoring devices on the front door of the AFD controller.

2.8 MOUNTING ACCESSORIES

Provide anchor bolts, nuts, washers, and accessories and other adapter equipment necessary for mounting the pumping equipment and appurtenances. Provide anchor bolts, nuts, washers, accessories and adaptor equipment made of Series 300 stainless steel. For bolts or studs engaging tapped holes in pump components, use silicon bronze or Series 300 stainless steel, as required for strength. Obtain approval from the ENGINEER for details of pump mountings before starting work on any structure for this equipment.

2.9 ACCESSORIES

A. Provide each pump with suction and discharge gauges having a minimum of 4-1/2-inch diameter dials plainly marked. Provide suction gauges of the compound type to indicate both vacuum and pressure. Discharge gauge shall be pressure type. Locate gauges as close as possible to the nozzles of the pumps. Connect each gauge with stainless steel pipe, fittings and isolating stopcocks. Equip each gauge with a snubber and threaded protective diaphragm seal made of stainless steel. Provide the scale range of each gauge as specified.

B. Provide inline three-way valve prior to gauge and pressure switch connections to allow for flushing of accumulated solids. Provide 10 feet of hose directed to a common drain point from the flushing connection.

C. Provide each pump with a sewage air release valve mounted at the top of the motor's coolant passage and arranged to allow entrained air to escape. Provide separate piping of the valve's discharge to the wetwell.

D. Provide a differential pressure switch for each pump discharge valve.

2.10 SOURCE QUALITY CONTROL

A. Perform a certified shop test on each pumping unit in accordance with the test code of the Hydraulic Institute, except as modified herein. Test the pumps with their suction elbows in a dry pit and in the position that they will be installed. Furnish the certified shop test curves along with the raw test data, calculated results and sufficient information for computation and plotting of the curves.

B. Test at rated speed to determine the curves of head, brake horsepower, NPSH required, electric input kilowatts, and overall efficiency, wire to water, as a function of capacity. Take a minimum of ten points, including one at shutoff head. Take one point as near as possible to each specified condition of head and capacity and take one at the lowest head specified. Take the remaining points at capacities necessary to provide a uniform distribution of data. Express capacity in gallons per minute and express head in feet.

3. EXECUTION

3.1 INSTALLATION

Install all equipment in accordance with the manufacturer's recommendations and approved shop drawings. Complete all wiring and piping and make all necessary adjustments to equipment to provide a complete operational pumping installation.

3.2 FIELD QUALITY CONTROL

A. Furnish the services of a qualified representative of the manufacturer of the pumps and the drive units to inspect the completed installation, make any necessary adjustments, participate in the startup of the equipment, participate in the field testing of the equipment, place the equipment in trouble-free operation, and instruct the operating personnel in its operation and maintenance.

B. After installation of the pumping units, control equipment and all appurtenances, subject each unit to a field running test as specified in Division 1, under actual operating conditions. Perform the field tests in the presence of and as directed by the ENGINEER. Demonstrate that under all conditions of operation each unit:

1. Has not been damaged by transportation or installation.
2. Has been properly installed.
3. Has no mechanical defects.
4. Has been properly connected.
5. Is free of overheating of any parts.
6. Is free of overloading of any parts.
7. Is free of all objectionable vibration.

C. Test the pumps to demonstrate that the pumps and control system operate as specified. Promptly correct any defects in the equipment or failure to meet the requirements of the Specifications.

END OF SECTION

SUBMERSIBLE SEWAGE GRINDER PUMPS

1. GENERAL

1.1 DESCRIPTION OF WORK

A. This section includes the requirements for furnishing and installing submersible sewage grinder pumping units, together with base elbows, guide rail systems, liquid level controls, control panels, access covers and all appurtenances necessary for a complete installation.

B. Codes and standards referred to in this section are:

1. ASTM A48 - Specification for Grey Iron Castings

2. Hydraulic Institute Standards

3. IEEE 82 - Test Procedure for Impulse Voltage Tests on Insulated Conductors

4. NEC - National Electric Code

5. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

6. AFBMA 10 - Specifications for Metal Balls

C. Provide pumps of the vertical, centrifugal, heavy duty, nonclog, close-coupled, submersible type, each driven by submersible electric motor mounted as an integral part of the pump. Design the pumping units to pump unscreened raw sewage. Arrange the pumping equipment guide rails and base elbow for installation in the spaces shown on the Contract Drawings and in accordance with approved shop drawings. Design the pumping units for continuous and intermittent duty with ten starts per hour.

D. Provide pumps to operate at the capacities and heads and over the range of operating conditions specified without overloading, cavitation, or vibration. Furnish the pumps in accordance with the following requirements:

Items	Requirements	
	Unit 1	Unit X
Capacity at rating point, gpm	_____	_____
Total head at rating point, feet	_____	_____

Items	Requirements	
	Unit 1	Unit X
Overall efficiency, wire to water, at rating point, minimum, percent	_____	_____
Shutoff head, feet		
Maximum	_____	_____
Minimum	_____	_____
Capacity at secondary rating point, minimum, gpm	_____	_____
Total head at secondary rating point, feet	_____	_____
Overall efficiency, wire to water, at secondary head, minimum, percent	_____	_____
Capacity at reduced speed rating point, gpm	_____	_____
Total head at reduced speed rating point, feet	_____	_____
Diameter of sphere that will pass through pump, minimum, inches	_____	_____
Pump discharge diameter, minimum, inches	_____	_____
Pump speed, maximum, rpm	_____	_____
Low water elevation for continuous operation, feet	_____	_____
Wet well floor elevation, feet	_____	_____
Motor horsepower, hp		
Minimum	_____	_____
Maximum	_____	_____
Motor efficiency at full load, minimum, percent	_____	_____
Motor power factor at full load, minimum, percent	_____	_____
Locked rotor kVa/hp, maximum, (Motor) (NEMA) code letter	_____	_____

E. Design each pump to have a continuously rising characteristic curve from the rating point to shutoff head which passes through the rating point, and which meets or exceeds the specified heads and capacities, all within the Hydraulic Institute tolerances.

F. Provide submersible units capable of sustaining full reverse runaway speed without damage.

1.2 SUBMITTALS

Submittals shall be made by the Contractor in accordance with the procedures set forth in Section 105 – Control of Work, and as described below. The Contractor shall submit the following information for review and approval.

A. Submit working drawings, including arrangement and erection drawings of the equipment and equipment operating characteristics. Include the following:

1. Pump performance curves. Draw the curves for the specified conditions (including those at reduced speed). Plot head, input kilowatts, and overall efficiency, as a function of capacity from zero to maximum capacity.

2. General arrangement drawing of pumping unit, base elbow and guide rail system. Include equipment weight and anchor methods and materials.

3. Cross section drawing of pumping unit.

4. Parts list with materials of construction identified.

5. Motor performance characteristics.

6. Spare parts list.

7. Painting procedure.

B. Submit six (6) certified copies of the Shop Test results.

C. Submit the Operation and Maintenance manuals for the pumping equipment.

1.3 QUALITY ASSURANCE

A. Provide pumping equipment produced by a manufacturer who has regularly engaged in the design, manufacture, assembly and production of submersible sewage pumping equipment of the size and application as specified for not less than the last five years. In addition, the manufacturer shall submit a report documenting successful operation of three or more facilities within the USA of at least equal horsepower and speed that are similar in design and function to those being furnished for this contract; applicable to pumps in excess of 150 horsepower only. Each facility shall have units which have been operated a minimum of 10,000 hours over five years. Provide the names and telephone

numbers of the users within the documentation report for verification. Failure to submit the report with adequate documentation will be cause for rejection of the pumping equipment.

B. Rate the motor unit, and wet well wiring for service in hazardous Class 1, Division 1, Group D locations (where applicable).

1.4 SPARE PARTS

A. Provide the following spare parts for each pump:

1. One set of mechanical seals - upper and lower
2. One set of cable entry grommets
3. One set of "O"-rings
4. One set of Motor Bearings
5. One set of Wear Rings

B. Furnish a complete set of special wrenches, spanners, eyebolts and other special tools sufficient to completely dismantle and reassemble each kind and size of pumping unit. Provide tools of forged steel, case hardened, and full finished. Furnish the sets with a metal tool case with a handle and provision for padlocking.

2. PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for possible approval.

1. Flygt
2. ABS

2.2 GENERAL CONSTRUCTION

A. Provide stainless steel fasteners, bolts, nuts and washers where exposed to the pumped liquid.

B. Provide machined metal-to-metal joints on component parts that are assembled together. Fit with an "O" ring seal where watertight joints are required. Arrange the "O" ring seal for automatic compression and sealing without adjustment or bolt torquing procedures. Do not use flat gaskets or sealing compounds to obtain watertight joints. Furnish machined rabbet fits on component joints as required to provide automatic alignment of rotating parts.

2.3 CASING

A. Provide pump casing of the centrifugal single volute, centerline discharge type. Do not use diffusion vanes.

B. Construct pump casing of ASTM A48 cast iron.

C. Construct renewable wear rings of stainless steel.

2.4 IMPELLER

A. Design impeller of the enclosed non-clog type, specially hardened and sharpened for grinding raw domestic sewage. Provide pump-out vanes or a back ring arranged with minimum clearances so as to preclude solids and stringy material from damaging the mechanical seal on the back of the impeller.

B. Construct the impeller of cast iron ASTM A48 hardened and sharpened for grinding raw domestic sewage.

C. Dynamically balance the impellers.

D. Construct renewable impeller wear ring of stainless steel.

E. Construct stationary cutter plat of hardened 316L stainless steel.

F. Secure the impeller to the shaft with a stainless steel key and lock nut in such a way that it cannot unscrew or become loosened due to rotation in either direction.

2.5 OIL CHAMBER

A. Provide an oil chamber to function as a buffer between the pumped liquid in the casing and the motor. Arrange the oil chamber to accommodate thermal expansion of the oil. Furnish an oil chamber drain plug that is accessible from outside the pump unit and permits changing oil without dismantling pump components.

B. Construct the oil chamber of ASTM A48 cast iron.

2.6 MECHANICAL SEAL

A. Provide each pump with a double or tandem mechanical seals. Design the upper seal unit, between the oil chamber and motor housing, with one stationary ceramic or tungsten-carbide ring and one positively driven rotating carbon ring. Design the lower seal unit, between the pump casing and oil

chamber, with one stationary ring and one positively driven rotating ring. Furnish these rings made of either tungsten-carbide or ceramic. Use stainless steel for metal parts. Protect the spring element of the lower seal from solids contained in the pumped liquid. Do not rely upon the pumped liquid for lubrication. No seal damage is to result from operating the pumping unit out of its liquid environment.

2.7 MOTOR

A. Provide submersible pump motor of 460-volt, 3-phase, 60-hertz. The motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber.

B. Design the motor to have suitable output torque and speed characteristic to start and operate the pump over the range of specified conditions. For constant speed pumping units do not exceed the nameplate horsepower rating under maximum load conditions. For pumping units operated from variable frequency drives, provide a motor nameplate horsepower rating at least 15 percent greater than the maximum load conditions. Base the nameplate horsepower rating on an 80 degrees C temperature rise above an ambient temperature of 40 degrees C. Design the motor for continuous load operation and continuous on-off cycling of ten starts per hour minimum without exceeding the 80 degree C temperature rise.

C. Provide the motor with a minimum of NEMA Class F (155 degrees C) moisture resistant insulation. Construct stator coils with NEMA Class H (180 degrees C) insulated winding wire. Apply impregnation resin to stator assembly in three dip and bake steps.

D. Provide the motor with an ASTM A48 cast iron stator housing. For motors that employ cooling water jackets, design the water jacket passages to preclude clogging by solids contained in the pumped liquid.

E. Provide the motor cable entry with a mechanical locking ring or compression type cord grip to protect the cable jacket from being pulled out of the motor. Do not use epoxy for this purpose. Arrange the cable entry so as to provide a watertight seal. Isolate the cable entry leads from the internal motor leads to prevent entry of water into the motor chamber by leakage or wicking. Provide cables suitable for submersible pump application and conforming to NEC specifications for cable sizing.

F. Shaft

1. Provide a one piece, fully machined pump and motor shaft. Design the shaft to limit shaft deflection under maximum pumping load to .002

inches at the lower mechanical seal face and to obtain a rotating assembly first critical speed of not less than 150 percent of the rated speed.

2. Provide shafts of either carbon steel or stainless steel. Protect carbon steel shafts from exposure to the pumped liquid by employing a stainless steel sleeve or chrome plating.

G. Bearings

1. Provide two antifriction bearing assemblies. Design one assembly to carry only radial loads and to be free to float axially within the frame. Design the other assembly to carry both radial and axial loads and to be restrained from axial movement.

2. Select bearings in accordance with AFBMA 9 and AFBMA 10, Load Ratings and Fatigue Life for Ball and Roller Bearings, to have a 20,000 hours minimum L_{10} bearing life at maximum pumping load that occurs under the specified operating conditions.

2.8 PROTECTION MONITORING SYSTEM

A. Provide each pumping unit with a monitoring system to protect critical machine functions during operation. (Design Engineer to specify critical machine functions.)

B. Provide a moisture sensor in the oil chamber to protect against damage from water contamination. Initiate alarm and motor shutdown upon sensing moisture.

C. Provide a monitoring device or devices designed to be compatible with the sensors and motor controls. Locate monitoring devices in _____.

2.9 GUIDE RAIL SYSTEM AND BASE ELBOW

A. Provide each pump with a base elbow and guide rail system. Design the guide rail system to permit installation and removal of the pump from its base elbow discharge connection without requiring personnel to enter the wet well.

B. Provide a cast iron guide bracket which is an integral part of the pump casing and permits sliding the pumping unit, along two unthreaded stainless steel guide rails. Provide the guide rails of Schedule 40 stainless steel pipe connected to the base elbow at the bottom. Support the guide rails at intermediate locations and at the top with stainless steel brackets bolted to the wall of the wet well or concrete slab. Fit each pump with a stainless steel cable

of adequate length and strength to permit the raising and lowering of the pump for inspection and removal.

C. Provide a cast iron base elbow arranged for automatic pump connection. Provide the pump casing with a machined discharge flange which, when the pump is lowered into the pumping position, will automatically align and mate with the plain-end of the base elbow. Design the discharge connection such that no motion other than vertical is required to seat the mating flange of the casing to the base elbow. Accomplish sealing of the pump connection by metal-to-metal contact or by a positive resilient seal of Buna-N attached to the pump casing discharge flange. Design the base elbow to support the weight of the pumping unit and prevent it from bearing directly on the wet well floor.

D. Provide anchor bolts, nuts, washers, and accessories and other adapter equipment necessary for mounting the pumping equipment and appurtenances. Construct anchor bolts, nuts, washers, accessories and adaptor equipment of Series 300 stainless steel.

2.10 SOURCE QUALITY CONTROL

A. Perform a shop test on each pumping unit in accordance with the test code of the Hydraulic Institute, except as modified herein. Test the pumps in the position that they will be installed.

1. Test at rated speed to determine the curves of head, electric input kilowatts, and overall efficiency, wire to water, as a function of capacity. Take a minimum of six points, including one at shutoff head. Take one point as near as possible to each specified condition of head and capacity. Take the remaining points at capacities necessary to provide a uniform distribution of data. Express capacity in gallons per minute and express head in feet. Furnish with the certified shop test curves along with the raw test data, calculated results and sufficient information for computation and plotting of the curves.

3. EXECUTION

3.1 INSTALLATION

A. Install all equipment in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1. Complete all wiring and piping and make all necessary adjustments to equipment to provide a complete operational pumping installation.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Furnish the services of a qualified representative of the manufacturer to provide instruction on proper installation of the equipment, inspect the completed installation, make any necessary adjustments, participate in the startup of the equipment, participate in the field testing of the equipment and place the equipment in trouble-free operation.

B. After installation of the pumping units, control equipment and all appurtenances; subject each unit to a field running test under actual operating conditions. Perform the field tests in the presence of and as directed by the ENGINEER. Demonstrate that under all conditions of operation each unit:

1. Has not been damaged by transportation or installation.
2. Has been properly installed.
3. Has no mechanical defects.
4. Has been properly connected.
5. Is free of overheating of any parts.
6. Is free of overloading of any parts.

Test the pumps to demonstrate that the pumps and control system operate as specified. Promptly correct any defects in the equipment or failure to meet the requirements of the Specifications.

END OF SECTION

ADJUSTABLE FREQUENCY DRIVES

1. GENERAL

1.1 DESCRIPTION OF WORK

A. This section includes the requirements for providing, installing and testing the 480-volt adjustable frequency drives. Provide drives in individual free standing enclosures, wall mounted enclosures, or incorporated into motor control centers, as shown. Furnish harmonic studies as specified.

B. Codes and standards referred to in this Section are:

1. NEMA ICS 1 - General Standards for Industrial Control and Systems

2. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Not More than 2000 Volts AC or 750 Volts DC.

3. NEMA ICS 3 - Industrial Control and Systems Factory Built Assemblies

4. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives

5. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems

6. NEMA 250 - Enclosures for Electrical Equipment

7. NFPA 70 - National Electrical Code

8. IEEE 85 - Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery

9. IEEE 519 - IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

10. UL 845 - Motor Control Centers

C. Design Requirements:

1. Provide adjustable frequency drives to vary the speed of NEMA standard, 3-phase, 460-volt, induction motors and driven equipment by varying the frequency and voltage applied to the motors.

2. Provide adjustable frequency drives that fit in the space shown. Units exceeding the dimensions shown will not be acceptable.

3. Provide adjustable frequency drives that automatically restart when power is restored after a power outage. Provide control logic so the drive is allowed to restart when power is restored.

D. Provide adjustable frequency drives with an output that is at least 3 percent greater than the driven motor's full nameplate rating.

E. Provide variable torque or constant torque output drives as required by driven equipment.

F. Provide adjustable frequency drives serving motors 75 HP or smaller that utilize 6-pulse drive technology.

G. Provide adjustable frequency drives serving motors 100 HP or larger that utilize 18-pulse drive technology.

H. Provide adjustable frequency drives to meet the following requirements of IEEE 519:

1. Total harmonic distortion THD (Voltage): Maximum of five percent for general distribution systems as measured at the point of common coupling.

2. Total current harmonic distortion: Not to exceed the values in Table 10.3, Current Distortion Limits for General Distribution Systems (120 V through 69000 V) of IEEE-519 at the point of common coupling.

3. Capacitor traps for controlling harmonics that require tuning to the power system are not acceptable.

4. Operate at a minimum efficiency of (95) (___) percent at rated load.

5. Operate from a 480-volt, 3-phase, 60-hertz supply with a voltage variation of plus 10-percent or minus 20-percent and a frequency variation of plus or minus 2-hertz.

6. Input power factor: Maintain a 95 percent minimum power factor over a 20 to 100 percent speed range.

7. Operate an induction motor as specified, including a high-efficiency, high-power factor, premium-duty motor, with no detriment to motor life.

8. Operate an induction motor without exceeding a motor sound and power level of 96-decibels, A-weighted, when measured in accordance with IEEE 85.

9. Operate under the following ambient conditions:

   a. Ambient Temperature: 0 to 40 degrees C
   b. Humidity: 0 to 95 percent

1.2 SUBMITTALS

Submittals shall be made by the Contractor in accordance with the procedures set forth in Section 105 – Control of Work, and as described below. The Contractor shall submit the following information for review and approval.

A. Furnish catalog data including rating and descriptive literature of all components and systems.

B. Furnish the following shop drawings customized for the project:

   1. Bill of materials including manufacturers name and catalog number

   2. Outline drawings showing dimensions, arrangement, elevations, identification of components and nameplate schedule for all units

   3. Interconnection wiring diagrams

   4. Individual schematic control diagrams for each unit

   5. One line diagrams

   6. Obtain and enter full performance data for all motors shown

   7. Certification that the adjustable frequency drives are compatible with the motors and the equipment loads to be driven

C. Furnish a system harmonic distortion study as follows:

1. Obtain data on utility services, plant loads and plant operation. Verify electrical service rating including transformer size, short circuit capacity and X/R ratio.

2. Prepare a harmonic distortion study of plant electrical system to determine voltage and current harmonics at the point of common coupling for worst case speed and load settings.

3. Confirm that the submitted adjustable frequency drives limit the electrical disturbances below the 5 percent THD (voltage) and below the harmonic current distortion per Table 10.3 as established by IEEE 519.

4. Point of Common Coupling: The point of common coupling is the motor control center or switchgear directly upstream of the adjustable frequency drive.

5. Include analysis of all data with recommendations.

D. Furnish test reports, certificates of inspection and manufacturer's instructions.

E. Furnish Operation and Maintenance manuals for the AFD unit(s).

1.3 QUALITY ASSURANCE

A. Provide all adjustable frequency drives manufactured in accordance with referenced standards.

B. Provide a UL Inc. Label or certification of listing by C.S.A. or other recognized testing organization for each adjustable frequency drive.

C. Manufacture and install each adjustable frequency drive in accordance with the NEC and local codes.

D. Failure to meet the harmonic requirement as determined by field measurement: If the installed adjustable frequency drives fail to meet the harmonic limits specified, modify the adjustable frequency drives as follows:

1. Perform work at no additional cost to the OWNER

2. Install additional harmonic reduction equipment until the specified limit is achieved.

3. In the event that harmonic distortion limits cannot be achieved, replace the adjustable frequency drive equipment with equipment that conforms to this specification.

1.4 SPARE PARTS

A. Furnish the following spare parts per (each type of drive) (each group of similar sized units)

1. All parts recommended by the manufacturer in published literature as spare parts. As a minimum, provide the following:

a. Six of all sizes and types of power and control fuses
b. Six LED displays of each color
c. One speed indicator meter relay
d. Two of each type of push button and selector switch used
e. Two keypads of each type used
f. Two printed circuit boards of each type used
g. Four filter capacitors of each size used
h. Four diodes of each type used
i. Four transistors, gate turn off thyristors IGBT's or SCRs of each type used
j. Three 12-ounce spray cans of the final finish for touch-up

B. Package spare parts in containers bearing labels and identify all spare parts for reordering. Deliver spare parts in original factory packages.

2. PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Robicon
2. Cutler-Hammer
3. Toshiba

2.2 DESIGN

A. Provide an input circuit breaker with an interrupting rating of 65,000 rms symmetrical amperes.

B. Provide input reactor or isolation transformer, if required, as determined by system harmonic distortion analysis.

C. Provide input section that converts 480-volts, 60-hertz, 3-phase input to a fixed dc voltage using diodes, bridged rectifiers or SCR's.

D. Provide dc link reactor and filter capacitors as required.

E. Provide adjustable frequency drive inverter section that converts the fixed dc voltage to an adjustable frequency output utilizing a pulse-width modulation inverter. Maintain a constant volts per hertz ratio on the output with voltage boost for startup as required.

F. Provide a digital operator keypad located on the front door to allow setting of all programmable parameters and the following control functions:

1. Start push button
2. Stop push button
3. "Local-Remote" control selection
4. Speed control settings
5. Speed meter with hertz and 0-100 percent scales
6. Output ammeter
7. Elapsed time meter
8. Diagnostics package with fault indication and reset push button

G. Provide a control system for each drive that allows the following functions:

1. Remote, isolated 4-20 ma speed control input
2. Isolated 4-20 ma speed output
3. Alarm outputs
4. ON/OFF status output
5. Additional features and controls as specified with the driven equipment

H. Include the following control adjustments for each drive:

1. Acceleration time, 4 to 60 seconds
2. Deceleration time, 4 to 60 seconds
3. Minimum speed limit
4. Maximum speed limit
5. Inverter current limit
6. Supply undervoltage trip

I. Protection Features: Provide the following drive protection features:

1. Input line current limiting fuses rated 200,000 rms symmetrical amperes short circuit current.

2. Electronic overcurrent protection for instantaneous overload

3. AC input line undervoltage protection, adjustable from 60-100 percent nominal voltage with time delay adjustment and low speed override.

4. Overfrequency protection

5. Phase loss protection

6. DC overvoltage protection

7. Logic supply voltage low level protection

8. Line-to-line and line-to-ground output short circuit protection

9. Line-to-line and line-to-ground surge arresters sized for 480-volt 3-phase grounded wye system

10. Overload capability of 110% of the motor FLA based on the NEC ratings for 60 seconds

11. Control circuit fuses

12. Overtemperature protection

13. Diagnostics module to indicate protection trip conditions

J. Communications: Provide an addressable communication card capable of transmitting the following data over a two-wire network to the Plant SCADA System:

1. Status (ON, OFF, TRIPPED, NO RESPONSE)

2. Input and output current in each phase

3. Output frequency

4. Input and output kW

5. Cause of trip

2.3 COMPONENTS

A. Provide circuit breakers, fuses, transformers, push buttons, switches, indicating lights, relays and timers as specified in (Section XXX).

B. Provide power solid state switching components with a one minute current rating greater than 110 percent of rated current for variable torque drives or 150 percent of rated current for constant torque drives.

C. Provide programmable controller (as specified in (Section XXX) Instrumentation).

D. Furnish a constant voltage control power transformer to maintain control power with supply voltage variations from 70-110 percent nominal.

E. Apply a clear conformal coating of acrylic to all printed circuit boards.

2.4 ENCLOSURES

Provide adjustable frequency drive drives in NEMA 1 filtered and gasketed enclosures with full rear cover plates.

2.5 IDENTIFICATION

A. Provide identification of the adjustable frequency drives and their components.

B. Install nameplates for devices located on doors so they are readable to a person 5'-8" tall standing 3'-0" in front of the equipment.

C. Locate nameplates so that they are readily associated with items labeled.

D. Where nameplates are installed on removable relay or device doors, install an additional nameplate within the relay or device.

E. Where nameplates are located on other compartments than those served, add additional engraving to identify units served.

2.6 WIRING

A. Provide internal wiring with stranded switchboard wire having 600-volt rated, flame-resistant, type SIS insulation. Use No. 14 AWG wire for control interconnections. Provide power connections as required for the service.

B. Provide wire markers at each end of all wires.

C. Where wiring connections are made to equipment mounted on hinged doors, provide connections with extra flexible wires suitably cabled together and cleated.

D. Provide wiring of all control connections to all external connections through individual, positive-latch, pull-apart type control terminal blocks rated 600-volts. Locate terminal blocks for front access.

E. Provide sufficient terminals for all devices external to the adjustable frequency drive.

2.7 SOURCE QUALITY CONTROL

A. Shop test each adjustable frequency drive in accordance with IEEE and NEMA standards, including high potential tests and other standard tests for that particular class of equipment. Notify the OWNER fourteen (14) days prior to start of factory testing so that the OWNER, at his option, may witness the testing.

1. After final assembly, test each adjustable frequency drive at full load with application of line-to-line and line-to-ground bolted faults and show that the adjustable frequency drive trips electronically without device failure.

2. After all tests have been performed, burn-in each adjustable frequency drive for 40 hours at 100 percent inductive or motor load.

3. After the burn-in cycle is complete, subject each adjustable frequency drive to a 30 minute cycling motor load test before inspection and shipping.

B. After the equipment has been completely assembled, perform operational test to determine operating conditions and circuit continuity. Provide pushbuttons and selector switches to simulate all control input contacts and indicating lights to indicate all control outputs. Provide a 4-20 ma signal generator to simulate analog signals.

C. Provide all equipment, devices, instrumentation, and personnel required to perform the tests. Upon satisfactory completion of the test, submit two (2) certified copies of the test report to the ENGINEER. Component failure during testing will require repeating any test associated with the failure or modified components to demonstrate proper operation.

3. EXECUTION

3.1 INSTALLATION

A. Install all equipment in accordance with the manufacturer's recommendations and approved shop drawings.

B. Set all circuit breakers per the approved short circuit and coordination study.

C. Set all operational devices for proper system operation.

D. Terminate and label all field wiring per approved drawings.

3.2 FIELD QUALITY CONTROL

A. Inspect, adjust and check the installation for physical alignment, cable terminations and ventilation.

B. Perform the following field tests:

1. Close and open each circuit breaker to test operation

2. When site conditions permit, energize and de-energize each equipment item served by each drive, testing the complete control sequence of each item including acceleration and deceleration over complete operating range.

3. Perform a harmonic system analysis to demonstrate full compliance with IEEE 519 voltage and current harmonic distortion requirements specified. Accurately measure the amplitude of the harmonic current imposed on the 60-hertz sine wave with a harmonic spectrum analyzer. Provide additional harmonic reduction equipment to meet the specified limits. If the harmonic distortion limits are not achieved, replace the adjustable frequency drive equipment with equipment that conforms to this specification.

4. Operate each adjustable frequency drive with driven equipment at full load and test for hot spots.

5. Furnish detailed test reports of all tests indicating test performed, discrepancies found, and corrective action taken.

C. Manufacturer's Field Services Representative: Provide the services of a factory-trained service engineer, specifically trained on the adjustable frequency equipment to assist in installation, start-up, testing, calibration, placing into operation, and provide training.

1. Provide a service engineer when each drive is placed into operation.

2. Provide a service engineer at the jobsite as often as necessary until all problems are corrected and the equipment installation and operation are satisfactory.

3. Following completion of installation and field-testing provide training for (12) (___) employees of the OWNER in the proper operation, troubleshooting and maintenance of the equipment as outlined below. All training will be at the OWNER'S facilities at a time agreeable to the OWNER:

   a. A minimum of two 4-hour sessions combining both classroom and hands-on instruction, excluding travel time.

   b. A minimum of two 4-hour sessions combining both classroom and hands-on instruction, excluding travel time.

4. Provide service engineer at the job site as often as necessary to assist in the programming of the SCADA system in accessing the memory map of each device.

END OF SECTION

PACKAGED ENGINE GENERATOR SYSTEMS

1. GENERAL

1.1 DESCRIPTION OF WORK

A. This section includes the requirements for providing a packaged engine generator system to supply standby electrical power as specified and shown. The system shall consist of:

1. (Natural gas) (Diesel) engine-driven generator and radiator mounted on a structural steel base.

2. Exhaust silencer and fittings.

3. Fuel storage tank, fuel pipelines and fittings.

4. Generator control and instrument panel.

5. Generator circuit breaker.

6. Battery and charger including battery rack.

7. Vibration isolators.

8. Remote annunciator.

9. Weather protective enclosure (or General Purpose enclosure).

B. Codes and standards referred to in this section:

1.	ASTM A 185	-	Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
2.	ASTM A 615/A615M	-	Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
3.	NFPA 30	-	Flammable and Combustible Liquids Code
4.	UL 142	-	Steel Aboveground Tanks for Flammable and Combustible Liquids
5.	UL 1709	-	Rapid Rise Fire Tests of Protection Materials for Structural Steel

C. The generator unit is to function as an emergency/standby power source for use in the event of failure of the incoming normal power service and during normal exercising operations. The unit consists of a (gas powered) (diesel), engine-driven, generator mounted on a structural steel base, complete with instrument panel, generator circuit breaker, generator control panel, starting system, governor, engine jacket-water cooling system, exhaust silencer, radiator, voltage regulator, outdoor enclosure (if applicable), and all appurtenances necessary for a complete functioning generation system. The above ground fuel storage tank are to provide for continuous 48-hour operation of the system in the event of failure of normal power service.

D. Provide a minimum generator capacity of ___ kW at [____] volts, 3-phase, 60 hertz, 0.8 power factor and (1800)[____] rpm; at an elevation of [____] feet above sea level; at an ambient temperature ranging between [____] degrees to [____] degrees F. Provide a generator system capable of starting and running a squirrel-cage induction [____] hp motor starting by (reduced-voltage, auto-transformer starter) (reduced-voltage, solid-state starter) (full-voltage starter) (adjustable frequency drive starter). The motors shall run in the sequence and with the starting device indicated, with a [____] kVa incidental load already on the generator bus and a voltage drop not exceeding 20 percent.

1.2 SUBMITTALS

A. Submittals shall be made by the Contractor in accordance with the procedures set forth in Section 105 – Control of Work, and as described below. The Contractor shall submit the following information for review and approval.

1. Furnish calculations to support the generator's capacity to start and operate the motors listed in Subsection 1.1 D.

2. Furnish starting battery sizing calculations.

B. Furnish product data and information showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, fuel tank, cooling system, and remote annunciator.

C. Furnish Contractor's shop drawings showing plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.

D. Furnish the manufacturer's certified, shop-test report including the following tests:

1. Generator tests in accordance with IEEE Test Code for synchronous machines including heat run at rated output, insulation resistance and high potential.

2. Engine generator tests in accordance with specifications including the following:

   a. Two hours continuous operation at full load.
   b. One-half hour at 75 percent of full load.
   c. One-half hour at 50 percent of full load.

   Furnish test reports indicating voltage, amperes, kilovolt-amperes, kilowatts, rpm and fuel consumption for the load condition as curves; and containing statements on temperature rise of oil and cooling water, vibration and other objectionable performance conditions. Furnish test data showing voltage drop and frequency fluctuations when block loads are added and removed in 25 percent, 50 percent, 75 percent and 100 percent increments.

3. Furnish manufacturer's installation instructions.

E. Furnish manufacturer's operation and maintenance manuals.

F. Furnish record documents, accurately indicating the locations of engine generator and mechanical and electrical connections.

1.3 WARRANTY

Furnish a written warranty for a period of not less than (two) years from the date of acceptance of the system covering, but not limited to, the following:

1. Repair parts
2. Labor
3. Travel expense
4. Expendables made unusable by the defect and used during a repair

1.4 SPARE PARTS

A. Furnish the following spare parts.

1. Two auxiliary relays and contactors of the type used.
2. Two fuse replacements of the type used.
3. Two replacements of all types of indicating lamps and color caps used.
4. Two-time delay relays of the type used.
5. One current transformer of the type used.

6. One potential transformer of the type used.
7. Two Start/Stop push buttons and selector switch of the type used.
8. One automatic voltage regulator.
9. Three full sets of fuel, air and oil filters.
10. Two complete sets of V-belts.
11. One compression tester.

B. Pack spare parts in containers bearing labels clearly designating contents and related pieces of equipment. Deliver spare parts in original factory packages. Identify all spare parts with information needed for reordering.

2. PRODUCTS

2.1 MATERIALS

A. Provide inline or vee type, water-cooled, (gas powered) (diesel) engine with, [_____] cylinders, turbo-charged, four-stroke cycle compression operating on (natural gas) (No. 2D diesel fuel oil). Provide an engine equipped with fuel, lube-oil and air-intake filters with replaceable elements; lube-oil cooler, gear-driven coolant pump, fuel-priming pump, fuel-transfer pump, engine-jacket water heater and pressure relief and bypass valves Provide an engine having exhaust-valve seats replaceable with inserts. Provide the engine directly connected to the generator and the set mounted on a common structural-steel base through suitable, spring type, vibration isolators.

1. Provide a fuel/water separator mounted ahead of the fuel pump on the engine generator set to remove fuel tank condensation and to prevent water from entering the engine fuel system.

2. Provide an engine-driven, gear-type, lubricating oil pump with removable suction screen to force oil under pressure to all main, connecting rod, piston, wrist pin and cam shaft bearings, timing gears and governor operating mechanism. Provide a full-flow, lubrication oil filter of the replaceable cartridge type and lubrication oil cooler for the engine. Provide a bypass valve in the filter assembly to allow engine lubrication in case the filter is clogged. Fill the engine crankcase with an approved lubricating oil in accordance with the manufacturer's instruction.

3. Provide an electronic, isochronous governor to control the engine speed and maintain a steady-state frequency regulation within ± 0.25 percent (0.15 hertz) from no load to full load.

4. Provide an engine–mounted, thermal circulation type water heater incorporating a thermostatic switch to maintain the engine jacket water at

90 degrees F. Provide heaters suitable for operation on [____] volts, (single)(three) phase, 60-hertz.

5. Provide an exhaust pipe and silencer suitable for residential grade installation, fabricated of welded Schedule 40 steel pipe and sweep elbows with the horizontal piping pitching downward away from the engine. Provide No. 316 stainless steel flexible connectors to connect the engine exhaust silencer and exhaust stack. Provide a valved silencer drain with a drip pocket having a minimum capacity of two gallons. Provide "Metal-On" insulation a minimum 2-inch thick with aluminum cover over exhaust pipe and silencer.

6. Provide a corrosion-inhibited cooling solution of water and ethylene glycol rated for 40 degrees F operating temperature for the cooling system.

   Equip the engine with an engine-mounted radiator, blower fan and close fitting shroud, sized to provide cooling for the engine jacket water, lubricating oil and after-cooler water cooling requirements. Provide a rigid guard to enclose both the top and sides of all moving parts between the engine and the radiator. Provide the radiator with a duct flange.

B. Generator:

1. Provide the generator rated for continuous standby service at [____] kW, [____] kVA at 0.8 power factor, [____] volts, three phase, three/four wire, delta/wye connected, 60 Hertz, [_____] rpm, with a temperature rise not exceeding [_____] degrees C in an ambient temperature of 40 degrees C.

2. Provide the generator as a [___] pole, salient pole, synchronous, revolving field, static regulated, brushless exciter with Class F insulation in a totally enclosed fan-cooled enclosure connected to the engine through a flexible coupling and a ring bolted to the flywheel housing.

3. Provide the generator with the rotor dynamically balanced within .0005 in. peak-to-peak amplitude displacements at both ends of the shaft, capable of sustaining 25 percent overspeed.

4. Provide the generator with stator and rotor windings of the layered form wound design with amortisseur windings furnished in pole faces having welded-type connections.

5. Provide the generator excitation system consisting of a rotating rectifier assembly, 3-phase ac exciter and solid-state voltage regulator. Provide

exciters that consist of a stationary field structure and a revolving armature. Provide surge suppressors to protect the rotating rectifiers.

6. Provide the generator capable of withstanding 10 percent overload current for two hours and 50 percent overload current for one minute without injurious heating at the rated power factor and the exciter field set for normal rated load excitation.

7. Provide the generator having a minimum combined efficiency of 95 percent with the exciter and voltage regulator at rated, full-load current.

8. Provide the generator, exciter and regulator with radio and TV noise suppression.

C. Automatic Voltage Regulator:

1. Provide an automatic, high-speed, solid-state, static voltage regulator mounted in the generator control panel arranged to monitor the generator output voltage in all three phases and apply corrections to generator excitation for variations in the voltage due to changes in generator load current, engine speed and load power factor.

2. Provide the voltage regulator to maintain generator output voltage within plus or minus one percent of the rated voltage from no load to full load, and momentary voltage drop at a maximum of 20 percent of rated voltage when full load is applied.

D. For the generator, provide an enclosed circuit breaker to act as a service disconnect and overcurrent protection.

1. Provide a low-voltage, enclosed circuit breaker rated at [___] amperes at (480)[____] volts, 3-phase, 60-hertz.

2. Provide circuit breaker protection programming set points selectively coordinated with the loads served.

3. Provide current transformers with [___]/5 amps ratio and potential transformers with [_____]/120 ratio volts (as required) within the structure housing the circuit breaker.

E. Generator Control and Instrument Panel:

1. Provide an illuminated, generator control and instrument panel of solid-state or microprocessor-based design housed in a NEMA 12 enclosure

and mounted on the engine-generator set base containing, but not limited to, the following:

a. Oil pressure gauge with low-pressure cut-off switch.
b. Water temperature gauge with high temperature cut-off switch.
c. Emergency stop button.
d. Frequency meter and running time meter.
e. Overspeed and overcrank switches.
f. Ammeter and voltmeter and phase switches for the generator.
g. Governor and voltage controls.
h. Manual ON and OFF switch.
i. Common alarm contact to signal failure of unit.
j. Alarm panel with six LED type alarm lights or digital readout with fault code program and output contacts, as follows:

(1) High water temperature
(2) Engine over crank
(3) Low lube oil pressure
(4) Engine overspeed
(5) Selector switch "off"
(6) Emergency stop

k. Two-wire, remote, start/stop termination.
l. Oil low-level switch.
m. Water low-level switch.
n. Battery charger.
o. Indicating lights.
p. "Push to Test" button and circuitry to test all indicating lights.

2. Provide all safety devices necessary for the protection of the engine generator set that alarm and shut down the set.

F. Dc Engine Starting System:

Provide a dc powered, engine-starting system consisting of batteries and battery charger operating at [___] volt dc.

a. Batteries

Provide a set of lead-acid storage batteries of the heavy-duty, diesel starting type having the required system dc voltage and adequate ampacity for six series of four cranking cycles of 15 seconds "ON" and 10 seconds "OFF" at the worst ambient temperature without recharging. Provide the battery set mounted on a metal battery rack with the necessary cables and clamps.

b. Battery Charger

Provide an automatic-float battery charger consisting of a silicon-controlled rectifier to provide a constant voltage output, with the necessary transformer to operate from a 115-volt, 1-phase, 60 Hertz lighting circuit. Provide a charger having a dc voltmeter, dc ammeter, equalizer timer and control switch, and sufficient ampere rating to maintain the charge on the engine starting battery. Provide a charger with protection against short circuits, overloads and reverse battery connections. Provide a charger capable of fully recharging the completely dead batteries in 8 hours time.

G. Weather Protective Enclosure (If not enclosed in a structure):

1. Provide the engine generator set and all accessories factory installed within a weather protective NEMA 3R enclosure of 12-gauge steel construction. Provide the enclosure with at least one access door on each side and one access door in the rear, with provisions for being locked and keyed alike.

2. Provide the enclosure with fixed air-intake louvers and an expanded-metal exhaust-air opening. Mount the exhaust silencer on the roof of the enclosure with an exhaust elbow and rain cap.

3. Provide internal bracing as required.

4. Provide an enclosure suitable for sound attenuation such that the noise level does not exceed 65 dBa at23 feet, with the engine generator set operating at full load.

H. Above Ground Fuel Storage Tank:

1. Provide an above-ground, vaulted tank consisting of an internal steel tank encased in a reinforced concrete vault. Provide outer cover molded in two pieces for ease of internal tank inspection, repair, or replacement. Provide vault mounted on legs, which are cast integrally with the lower half of the concrete shell. Provide a tank system that complies with all governing code requirements as interpreted by authorities having jurisdiction.

2. Provide a storage tank with a capacity of _____ gallons minimum.

3. Provide an internal steel tank suitable for above-ground storage of flammable liquids at atmospheric pressure, complying with the

requirements for a stationary installation in accordance with NFPA 30 and constructed in accordance with UL 142 specifications, including pressure testing at 5 psi for one hour. Provide a steel tank constructed of 7-gauge steel or thicker, welded to conform to Welding Society standards for continuous welds and having a 30-year warranty. Cover the exterior with a rust-preventative, oxide coating. Support the tank on cylindrical ribs lined with a petroleum resistant gasket to prevent galvanic action.

4. Provide a concrete vault shell constructed of 6 inches of reinforced concrete, using Portland cement with 4000-psi strength at 28 days, reinforcement bars conforming to ASTM A 615, Grade 40 minimum, and welded wire fabric conforming to ASTM A 185. Provide a shell consisting of upper and lower halves, with legs constructed monolithically with the lower half. Provide an interstitial space between tank and vault to exceed 110 percent of requirements for secondary containment. Cover the inside of the concrete shell with a coating of petroleum-resistant material for enhanced secondary containment. Provide a joint between the two halves that is of a two stage, ship lap configuration, including an outer fire gasket of 2400-degree F rated, aluminum-silicon ceramic, refractory insulation, and an inner moisture and vapor gasket of petroleum-resistant, Concrete Sealant CS-440, extruded non-hydrocarbon elastomer meeting the requirements of UL 1709 for rapid-fire rise in a 4 hour test, and exceeding the minimum 2-hour, fire-wall tests of the Uniform Fire Code.

5. Provide a shell with one 2-inch connection in the top, offset from the tank, for future interstitial leak monitoring.

6. Provide a tank having the following pipe nipples in the top, with adequate accommodation through the concrete shell and appropriate fittings, covers and level gauge for each nipple:

   One - 4-inch fill port with 5-gallon overspill containment
   One - 4-inch port for level gauge
   One - 4-inch spare
   One - 2-inch atmospheric vent
   One - 6-inch emergency vent
   One - 2-inch return
   One - 4-inch supply

3. EXECUTION

3.1 INSTALLATION

A. Install the engine generator set, fuel storage tank and day tank on concrete mounting pads or structures as shown, in accordance with manufacturer's instructions and approved shop drawings.

B. Install local ground. Make and test all electrical power, ground and control connections.

C. Make and test all fuel pipeline connections. Fill storage tank with fuel, bleed fuel pipelines to remove air and prime fuel pumps as per manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. Test start and run the engine generator set at no load for at least 30 minutes to check dc starting system, vibration free installation, fuel line leaks, all gauges and meters, engine rpm, generator voltage and to warm up the engine generator for the load test, as per the manufacturer's instructions.

B. Inspect all engine generator systems after initial test run for defects and rectify in accordance with manufacturer's instructions.

C. Carry out a field test of the engine generator system for 4 hours at full load in the presence of the ENGINEER. Furnish dry type load banks for the load test and provide precise incremental loading on engine generator till full load. Check phase voltages, current frequency, vibration, and temperatures as per manufacturer's instructions.

3.3 OPERATION DEMONSTRATION

A. Furnish the services of the engine generator manufacturer's representative to assist in installation, start-up, field testing, calibration, placing into operation and provide training, including the acceptance test run of the set. Have the representative carry out a thorough inspection of the installation; certify that the installation is correct and complete in accordance with the manufacturer's instructions; to confirm that the set is ready for acceptance test run; and to instruct operating personnel in the operation and maintenance of the set.

B. Have the manufacturer’s service representative perform the final acceptance test run of the engine generator set in the presence of the OWNER. Perform the final acceptance test run by simulating a power failure and observing automatic engine generator startup, acceleration to speed and assumption of available load at the site without any problems and as per claimed performance.

Demonstrate the compatibility of the engine generator with the adjustable frequency drives and solid-state starters used for motors, and its capability to start and operate the loads in the desired sequence. Also demonstrate that the engine generator is capable of starting and sustaining the load with a voltage drop of not more than 20 percent of the rated value. Simulate and demonstrate that the alarm and shut down features operate satisfactorily.

C. Following completion of installation and field-testing furnish training for (12) (___) employees of the OWNER in the proper operation, troubleshooting and maintenance of the equipment. All training will be at the OWNER'S facilities at a time agreeable to the OWNER. Training shall be a minimum of two 4-hour sessions combining both classroom and hands-on instruction, excluding travel time.

END OF SECTION

MAGNETIC FLOW METER

1. GENERAL

1.1 DESCRIPTION OF WORK

This section includes the requirements for furnishing and installing magnetic flow meters as specified or required for a complete installation. Locate the magnetic flow meters as shown on the Contract Drawings.

1.2 SUBMITTALS

1. Complete detailed drawings of all flow meter.

2. Working drawings, including arrangement and erection drawings of the flow meters; schematic control diagrams, electrical connection diagrams, and complete description of the control system.

3. Certified calibration data as required by subsection 2.1, paragraph A.8 below.

2. PRODUCTS

2.1 MAGNETIC FLOW METERS

A. Flow Elements

1. Electromagnetic type with pulsed dc coil excitation for zero stability. Suitable for aqueous solutions with minimum conductivity of 5 micromhos/cm. Insensitive to changes in fluid viscosity and density.

2. Flanged body design for 150 pound ANSI flanged pipe connections.

3. Sensor flow tube material: 304 stainless steel pipe, with 2 electromagnetic coils mounted on the exterior surface of the tube.

4. Furnish meter tube with a laying length of at least 1.3 times the nominal meter size.

5. Provide meter with hard rubber or polyurethane liner and type 316 stainless steel electrodes.

6. Enclosure classification: NEMA 4 / IP67 and capable of accidental submergence in 30 feet of water for up to 48 hours.

7. Electrical terminal boxes for flow sensors located in underground vaults, shall be backfilled with non-setting transparent potting material.

8. Hydraulically calibrate each meter at a flow facility against a master meter or other device which is traceable to the United States NIST. Submit certified calibration data and a calibration curve substantiating the stated accuracy. Submit information regarding the location of the flow facility and procedure being used to calibrate the meter.

9. Furnish and install meter with stainless steel grounding rings. Grounding electrodes will not be acceptable.

10. Meter accuracy: ±0.5 percent of actual flow rate for a range of 10 to 100 percent of maximum calibrated flow. Guarantee accuracy with no more than five pipe diameters of straight pipe run upstream from the meter.

11. Manufacturer: ABB (Fischer and Porter) Mag-XE, Endress+Hauser ProMag 53 series or equal.

B. Signal Converter:

1. Smart "Hart" protocol.

2. Provide remote mounted flow transmitter/converter, microprocessor based. Provide transmitter with integral LCD display of flow rate.

3. Provide input of configuration data, stored in EEPROM memory without need for battery backup.

4. Output:

a. 4-20 mAdc into 0-600 ohm load linearly proportional to flow, calibrated as scheduled.

b. Scaled Pulse totalizer output, suitable for 24 Vdc switching at 250 mA. Pulse width to be adjustable. Calibrate the pulse rate for 1,000 gallons per pulse.

5. Accuracy: ±0.5 percent of actual flow over 10:1 flow range.

6. Provide input span adjustment from 1.5-30 feet per second at full-scale flow. Meters requiring circuit or component changes to effect calibration changes will not be acceptable.

7. Operating ambient temperature: -4 to 140 degrees F.

8. Power requirement: 115 volts ac, 60 hertz.

9. Enclosure classification: NEMA 4 / IP67

3. EXECUTION

3.1 INSTALLATION

Install magnetic flow meters where shown in the Contract Drawings and in accordance with approved shop drawings and manufacturer's recommendations.

END OF SECTION

PRESSURE GAUGES

1. GENERAL

1.1 DESCRIPTION OF WORK

A. This section includes the requirements for furnishing and installing gauges and isolating devices as shown and specified.

B. Codes and standards referred to in this Section are:

ASME B40.1 - Gages - Pressure, Indicating Dial Type - Elastic Element

1.2 SUBMITTALS

Provide all submittals, including the following, as specified in Division 105 – Control of Work.

2. PRODUCTS

2.1 MANUFACTURERS

Acceptable manufacturers for gauges are listed below. Other manufacturers of equivalent products may be submitted.

1. Mastergauge by Marsh Instrument Company.

2. Supergauge by U.S. Gauge, a Division of Ametek, Inc.

3. Duragauge by Ashcroft, Industrial Valve and Instrument Division, Dresser Industries.

4. Helicoid Gauges by Helicoid Gauge Division, ACCO (American Chain and Cable Company, Inc.)

2.2 DESIGN

A. Provide gauges to include pressure, vacuum, and compound gauges of the dial-indicating bourdon tube type. Manufacture gauges to the requirements of ASME B40.1, Gauges, Pressure and Vacuum, Indicating Dial Type - Elastic Element, except as modified herein. Locate gauges as shown or specified.

(Wall mount or independently support gauges for the following vibrating equipment:)

B. Provide Grade 2A pressure gauges with a range of (0 to 60) (0 to 100) (etc.) psig, with an accuracy of 0.5 percent of the maximum scale reading.

C. Provide Grade 2A compound vacuum and pressure gauges a vacuum range of 0 to 30 inches of mercury and a pressure range of (0 to 60) (0 to 100) (etc.) psig with an accuracy of 0.5 percent of the maximum scale reading,

2.3 CONSTRUCTION

Construct gauges with a nominal size of (4-1/2) (6) inches. Provide (bottom) (rear) located pressure connection, (1/4-inch) (1/2-inch) NPT, male fitting extending a minimum of 1-1/4 inches beyond the case and with large wrench flats. Construct the bourdon tube and fitting of (bronze) (Type 316 stainless steel). Provide a weatherproof case of the (stem) (wall) (flush) mounted type, constructed of (shock-resistant plastic) (steel with a corrosion-resistant paint coating) (epoxy coated cast aluminum). Design the movement to be rotary gear or helical roller type designed to minimize wear and maintain accuracy. Make provisions for adjustment of zero reading. Manufacture dials white (black) faces with black (white) numerals and markings. Provide gasket sealed glass windows to prevent moisture and dust from entering the gauge case.

2.4 DIAPHRAGM SEALS

A. Furnish diaphragm seals to isolate the process fluid from the pressure gauge. Provide Grade 2A gauge (0.5 percent) seal and gauge combined accuracy of 1.0 percent of the maximum scale reading. Equip the seal with a 1/4-inch NPT pressure device connection and a 1/2-inch NPT process connection. Design the 2-1/2 inches minimum diameter seal for continuous duty, fitted with a 1/4-inch NPT flushing connection, and of the cleanout type. Manufacture the diaphragm of Type 316 stainless steel. Construct the lower and upper case of (steel with a rust-resistant coating) (Type 316 stainless steel) (PVC plastic) (Viton) (Teflon). Make all wetted parts corrosion resistant to the process liquid. Provide liquid filled case as recommended by the manufacturer. Factory assemble and calibrate all liquid filled pressure gauge-diaphragm seal units at the point of manufacturer and ship and install as a unit.

B. Provide sintered metal snubbers or orifice plate restrictors for pulsation dampening, and of (brass) (Type 316 stainless steel) construction. Locate pulsation-dampening devices adjacent to the pressure device.

C. Provide shutoff cocks, for each gauge, constructed of (brass) (Type 316 stainless) (plastic).

3. EXECUTION

3.1 INSTALLATION

Install pressure gauges in accordance with the manufacturer's recommendations and approved shop drawings.

3.2 SCHEDULE

Provide gauges as scheduled below:

Equipment System	Process Fluid	Building	Pressure or Vacuum Range	Materials of Construction	Diaphragm Seal Type
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

END OF SECTION

SUPPORTS AND ANCHORS

1. GENERAL

1.1 DESCRIPTION OF WORK

A. This section includes the requirements for providing all hanging and supporting devices of construction shown, specified, or required for pipelines, apparatus, and equipment other than electrical equipment.

B. Codes and standards referred to in this Section are:

1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, 800
2. ASME B31.1 - Power Piping (Includes Revision Service)
3. ASTM A 307 - Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
4. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture
5. MSS SP-69 - Pipe Hangers and Supports - Selection and Application
6. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices
7. MSS SP-90 - Guidelines on Terminology for Pipe Hangers and Supports

1.2 SUBMITTALS

Submit shop drawings to show the quantity, type, design and location of all supports, hangers and anchors required.

1.3 SYSTEM DESCRIPTION

A. System includes supporting devices adequate to maintain the pipelines, apparatus, and equipment in proper position and alignment under all operating and testing conditions with due allowance for expansion and contraction.

B. Design supporting devices in accordance with the best practice and provide supporting devices that are not unnecessarily heavy. Design supporting devices to accommodate loads imposed during leakage tests for the test pressures specified. Base the required strength of supporting devices on the combined weight of the piping and connected equipment, the weight of the denser of the fluids used in operations or testing and the weight of insulation where applicable. Install supports with a working safety factor of not less than 5.

C. Provide springs where necessary. Make hangers and supports of standard design where possible and best suited for the service required. Include proper pipe protection saddles for hangers and supports on pipes which are covered with insulation. Where required, make supports screw adjustable after installation unless approved otherwise.

D. Design all supporting devices so as to minimize interference with access and movement. Eliminate the potential for injuries due to protruding supporting devices.

E. Provide base piping support, hanger rod size, brackets and spacing meeting the requirements of ASME B31.1, MSS SP-58, SP-69, SP-89 and SP-90 except as modified herein.

Modify hangers for plastic pipes to increase the bearing area by inserting a protective sleeve of medium-gauge aluminum sheet metal between the pipe and the hanger.

a. Align hangers such that no sharp edges come in contact with the pipe.

b. Provide a wooden or thermoplastic pad between the plastic pipe and any concrete or masonry surface.

c. Use supports for vertical lines of a type which do not exert a compressive strain on the pipe. Riser-type clamps that squeeze the pipe will not be permitted.

2. PRODUCTS

2.1 MANUFACTURERS

Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Pipe hangers and supports

a. Grinnell Corporation, Cranston, RI
b. Globe Pipe Hanger Products, Inc., Cleveland, OH

2. Sheet metal shield

"Thermal-Hanger Shields" by Pipe Shields Incorporated, Vacaville, CA

2.2 MATERIALS

A. Use structural and miscellaneous steel, metal castings, ductile iron pipe and fittings, steel pipe and fittings.

B. Support overhead hangers using threaded rods properly fastened in place by suitable screws, clamps, inserts, or bolts, or by welding. Subject hangers to tensile loading only. Where lateral or axial movement may occur, provide suitable linkage to permit sway.

C. Suspended Piping: Support suspended piping by adjustable ring or clevis hangers and threaded rods from heavy-duty concrete inserts or other fastening devices, except as otherwise specified or noted.

D. Brackets: Make brackets of welded steel and designed for the following load classifications.

Load Classification	Maximum Load per Bracket
Light	750 pounds
Medium	1,500 pounds
Heavy	3,000 pounds

1. When medium or heavy brackets are bolted to vertical surfaces, furnish and install backplates of adequate size and thickness to distribute the load against the vertical surfaces.

2. When the use of backplates is not practicable, fasten the brackets to the vertical surfaces in such a manner that the safe bearing strength of the vertical surfaces will not be exceeded.

E. Chairs and Pipe Rolls: Use cast-iron pipe rolls or chairs. Provide pipe rolls with threaded nuts or with sockets to take threaded rods.

F. Saddle Stands: Use adjustable saddle stands.

1. Provide each stand with a length of steel pipe fitted at the base with standard threaded cast-iron flange or steel base plate and at the top with an adjustable saddle or roll. Bolt the base flange or plate to the floor, foundation or concrete base.

2. Use stanchions of construction similar to the saddle stand, except fit them at the top with cast-iron pipe saddle supports or with pipe stanchion saddles with yokes and nuts.

G. Insulation Support Requirements: At support points, protect insulated pipes by a 360-degree insert of high density, 100 psi, waterproofed calcium silicate encased in a 360-degree sheet metal shield.

1. Make inserts of the same thickness as the adjoining pipe insulation.

2. Provide the shield length, minimum galvanized sheet metal gauge and installation procedure in accordance with the manufacturer's recommendations.

3. Extend insulation inserts one inch beyond the sheet metal shields on cold water lines, and jacket and vapor seal as required when the abutting insulation is installed.

H. Expansion: Connect, support and guide piping to permit and control pipe expansion and contraction and to accommodate building expansion, contraction and settling without damage to the piping or support system.

1. Furnish and install anchors when specified, shown, or required for holding the pipelines and equipment in position or alignment. Design anchors for rigid fastening to the structures, either directly or through brackets.

2. Provide cast-iron chair type anchors for piping with steel straps, except where anchors form an integral part of pipe fittings or where an anchor of special design is required.

3. Inserts: Provide galvanized concrete inserts.

a. Design inserts to permit the rods to be adjusted horizontally in one plane and to lock the rod nut or head automatically.

b. Recess inserts near the upper flange to receive reinforcing rods.

c. Design inserts so that they may be held in position during concrete placing operations. Design inserts to carry safely the maximum load that can be imposed by the rod which they engage.

3. EXECUTION

3.1 INSTALLATION

Install hanger and supports in accordance with the manufacturer's recommendations and approved shop drawings.

END OF SECTION

MANHOLE AND WET WELL REHABILITATION AND COATING

I. GENERAL

1.1 DESCRIPTION OF WORK

A. This section include the requirements for providing a system for manhole rehabilitation that includes lining the manhole interiors, internal sealing of the frame-chimney joint area, and reconstructing manhole benches and channels. It is the Contractor's responsibility to stop all active leaks in association with the lining of the manhole interiors.

B. This work shall include the furnishing of all materials, equipment, tools, and labor as required for the rehabilitation of the manholes.

C. Rehabilitation products shall be applied to the manhole from the cover seat to and including the benches. The rehabilitation system must provide a non-prorated warranty as herein described in manholes to stop infiltration, prohibit root intrusion, protect the existing structure from further deterioration, and provide a surface coating resistant to sewer gases and chemicals.

D. Sewage pumping station wet wells shall also be rehabilitated and coated in accordance with this specification.

1.2 SUBMITTALS

Submittals shall be made by the Contractor in accordance with the procedures set forth in Section 105 - Control of Work, and as described below.

After notification of a specific project, the Contractor shall provide the following information for review and approval.

1. A comprehensive construction-sequencing plan. At minimum the plan shall include the following:

    a. A proposed schedule.
    b. Identification of all proposed access routes.
    c. Identification of set-up locations for lining installation.
    d. Lining procedures.
    e. Bypass Pumping Plan in accordance with Section 812 – Bypass Pumping.
    f. Traffic Control Plan in accordance with VDOT requirements.

2. Letter identifying the crewmembers performing the lining. If any of the crewmembers are not identified on the original certification letter received

during the pre-qualification process, then a new certification letter listing the crew member(s) must be received from the rehabilitated system supplier prior to initiation of the specific project.

3. Documentation of product experience. The documentation shall include at least 10 jobs similar in nature completed within the last two years. The jobs submitted shall show that the Contractor or other Contractors have installed at least 500 vertical linear feet of the product. Include the Owners name, the contact for the job including name, phone number, title, and address, the project description, the value of the job, and the date job was placed in service. Based on these references, the Owner reserves the right to reject the product and require the Contractor to submit another product meeting these specifications.

4. Documentation of Applicator experience. The documentation shall include at least 5 jobs similar in nature completed within the last two years. The jobs submitted shall show that the Applicator has installed at least 200 vertical linear feet of the product. Include the Owners name, the contact for the job including name, phone number, title, and address, the project description, the value of the job, and the date job was placed in service. In addition, submit certification that applicator(s) is approved by the manufacturer in application of the specified products. Based on these references, the Owner reserves the right to reject the Applicator and require the Contractor to submit the name(s) of another Applicator meeting these specifications.

5. Calculations (or certified letter from an officer of the manufacturer) supporting recommended liner thicknesses or wall coverage thicknesses.

6. Shop drawings and product data for the manhole rehabilitation method including a report outlining the process to be used in the rehabilitation of the sewer manholes. The report shall also include information specific to the job, such as coordination issues, access, timing, manufacturer's installation instructions and bypass pumping.

7. All measurements made by the Contractor to verify manhole elevations, prior to ordering of material.

II. EXECUTION

2.1 GENERAL

A. Prior to performance of the actual work carefully inspect the entire site and locate those manholes designated to be rehabilitated.

B. Cleaning: Cleaning of sewer lines and manholes shall be performed as specified in Section 810 - Sewer Line Cleaning.

C. TV Inspection: Inspection of sewer lines shall be performed as specified in Section 811 -Television Inspection.

D. Bypass Pumping: When required for acceptable completion of the rehabilitation process, the Contractor shall provide for adequate flow control including but not limited to required pumping and bypassing as stipulated in Section 812 - Bypass Pumping.

2.2 REHABILITATION PROCEDURES

A. Place cover over invert to prevent extraneous material from entering the sewer lines.

B. All foreign material shall be removed from the manhole wall and bench to produce a sound surface with adequate profile to provide a strong bond between the protective coating and the substrate as recommended by the manufacturer. This can generally be accomplished through the use of a high-pressure water spray (minimum 1200 psi), abrasive blasting, shotblasting, grinding, and/or scarifying. Detergent water blasting and hot water blasting may be necessary to remove grease, oils, and other hydrocarbon residues from the structure surface. Loose and protruding brick, mortar, and concrete shall be removed using a mason's hammer and chisel and/or scraper. Fill any large voids with quick-setting patching mix in accordance with Section 200 – Products and Materials. The surface to be repaired must be clean and free of any loose materials with walls totally saturated with water.

C. Minor leaks shall be stopped using the quick-setting specially formulated infiltration control mix and shall be mixed and applied per manufacturer's recommendations. Some leaks may require weep holes to localize the infiltration during the application, after which the weep holes shall be plugged with the quick-setting infiltration control mix prior to the final liner application. When severe infiltration is present, drilling may be required in order to pressure grout using a cementitious or chemical grout. Manufacturer's recommendations shall be followed when pressure grouting is required.

D. After all preparation work has been completed, remove all loose material and wash wall again.

E. Any bench, invert, or service line repairs shall be made at this time using the quicksetting patching mix per manufacturer's recommendations.

F. Invert Repair: Invert repair shall be performed on all inverts with visible damage or infiltration. After blocking flow through the manhole and thoroughly cleaning invert, the quick-setting patch mix shall be applied to the invert in an expeditious manner. The mix shall be troweled uniformly onto the damaged invert extending out onto the base of the manhole sufficiently to tie into the structural/structurally enhanced monolithic liner to be applied. The finished invert surfaces shall be smooth and free of ridges. The flow may be re-established in the manhole within 30 minutes after placement of the mix.

G. Cementitious Liner Installation

1. Described are procedures for manhole preparation, cleaning, application and testing. The applicator, approved and trained by the manufacturer, shall furnish all labor, equipment and materials for applying a cementitious mix with machinery specially designed for the application. All aspects of the installation shall be in accordance with the manufacturer's recommendations and with the following specifications which include:

    a. Elimination of active infiltration prior to the application.

    b. Removal of loose and unsound material and cleaning surfaces in accordance with Section 810 - Sewer Line Cleaning and per manufacturer's recommendations.

    c. Repair and sealing of the invert and benches.

    d. Spray application of a cementitious mix to form a liner.

2. Liner Application: Prior to liner application onto walls, manhole bench area shall be covered with plywood sections, which conform to the internal dimensions of the manhole, to prevent accumulation of liner material on bench.

    No application shall be made to frozen surfaces or if freezing is expected to occur inside the manhole within 24 hours after application. If ambient temperatures are in excess of 95º F, precautions shall be taken to keep the mix temperature at time of application below 90º F. Mix water temperature shall not exceed 85º F. Chill with ice if necessary.

3. Mixing: For each bag of product, use the amount of water specified by the manufacturer and mix for the duration and in the manner recommended by the manufacturer.

Empty the mixed material into the holding hopper and prepare another batch with timing such that the nozzleman can spray in a continuous manner without interruption until each application is complete.

4. Spraying:

    a. First Application: The surface prior to spraying shall be damp without noticeable free water droplets or running water, but totally saturated. Materials shall be spray applied from the bottom of the wall to the top, to a minimum uniform thickness to ensure that all cracks, crevices, and voids are filled and a relatively smooth surface remains after light troweling. The light troweling is performed to compact the material into voids and to set the bond.

    b. Second Application (as necessary per manufacturer's recommendations): A second application is to be applied after the first application has begun to take an initial set (disappearance of surface sheen which could be 15 minutes to 1 hour depending upon ambient conditions) to assure a minimum total finished thickness of ½ inch. Again application shall be from the bottom up. The surface is then troweled to a smooth finish being careful not to over trowel so as to bring additional water to the surface and weaken it. Manufacturer's recommendations shall be followed when more than 24 hours have elapsed between applications.

    c. Bench Application: The plywood covers shall be removed and the bench sprayed such that a gradual slope is produced from the walls to the invert with the thickness at the edge of the invert being no less than ½ inch. The wall bench intersection shall be rounded to a uniform radius equal to the full circumference of the intersection.

    d. The Contractor shall take precautions to keep overspray or excess material from entering the newly installed liner pipe and any other pipes in the manhole.

5. Curing: Caution should be taken to minimize exposure of applied product to sunlight and air movement.

    If application of second coat is to be longer than 15 minutes after completion of application of first coat, the manhole cover shall be set back in place. At no time should the finished product be exposed to

sunlight or air movement for longer than 15 minutes before replacing the manhole cover.

The final application shall have a minimum of 4 hours cure time before being subjected to active flow.

Traffic shall not be allowed over manholes for 6 hours after rehabilitation is complete.

Allow the finished cement process to have a minimum of 6 hours cure time, or as a minimum, the cure time recommended by the manufacturer, whichever is longer, before being subjected to active flow.

Testing: Four 3-inch by 6-inch test cylinders or six 2-inch cubes shall be cast each day or from every 50 bags of product used. The test specimen shall be properly labeled and sent in for testing in accordance with the manufacturer's directions for compression strength testing as described in ASTM C 495.

H. Cured-In-Place Fiberglass Insert: The installation of the approved liner system shall be in strict accordance with the manufacturer's written instruction. This shall include re- grouting all inlet and outlet lines and benches as needed, plus the preparation, installation, curing, and finish operation, for the completion of the rehabilitation process.

I. Epoxy Coating Installation: The installation of the approved epoxy coating system shall be in strict accordance with the manufacturer's written instruction. This shall include regrouting all inlet and outlet lines and benches as needed, plus the preparation, installation, curing, and finish operation, for the completion of the rehabilitation process. Any cementitious materials used under the epoxy coating for patching or repairs shall be as recommended by the epoxy coating manufacturer for compatibility.

2.3 LINER AND COATING ACCEPTANCE

All rehabilitated manholes shall be tested as follows:

A. Visually verify the absence of leaks.

B. Perform a vacuum test in accordance with Section 802 – Sanitary Gravity Sewer Systems.

C. (Optional – Perform an exfiltration test. For manholes up to 6 feet deep: A water loss of 1 inch or less in 5 minutes is acceptable. For manholes over 6 feet deep: A

water loss of 1 inch or less plus 1/8 inch per additional foot of depth in 5 minutes is acceptable.)

D. (Optional - wet film thickness gage meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.)

E. (Optional for epoxy coatings – Note that this procedure is sometimes difficult or impossible to perform in tight manhole or vault structures) After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment. Surface shall first be dried. An induced holiday shall then be made on to the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the induced holiday (refer to NACE RPO188-99). All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.

F. (Optional for epoxy coatings) Measurement of bond strength of the protective coating to the substrate shall be measured in accordance with ASTM D4541. 10% of the manholes being rehabilitated shall be tested at 3 locations. The Owner shall evaluate any areas detected to have inadequate bond strength. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and the Contractor shall make repairs in strict accordance with manufacturer's recommendations. At the discretion of the Owner, additional bond tests in the remaining manholes may be directed at no additional cost to the Owner. The Contractor shall make any repairs necessary at no additional cost to the Owner.

2.4 MANHOLE STEP REMOVAL

The Contractor shall remove all steps. Removal shall consist of neatly cutting steps flush with the wall prior to any lining installation. The Contractor shall be responsible for proper disposal of steps.

2.5 MANHOLE FRAME AND COVER REPLACEMENT

A. Excavation and site restoration in paved and unpaved areas shall be in accordance with Division 3, 5, and 6 of the Regional Construction Standards to a minimum of established pre-construction conditions.

B. The Contractor shall remove and dispose of the existing manhole frames and covers, as specified on the Drawings. It shall be the responsibility of the Contractor, at no additional cost to the Owner, to repair any damage to the chimney or corbel caused by the removal of the existing manhole frame.

C. New replacement frames and covers shall be as specified in Sections 200 – Products and Materials, Section 802 – Sanitary Gravity Sewer Systems, and the Regional Construction Standards Standard Details.

D. Repair of Manhole Chimney and Corbel, Requiring Excavation (when directed by the Owner):

1. In Paved Areas:

    a. The removal of the manhole frame shall be accomplished by making a square cut of sufficient size in the pavement.

    b. Material in the exposed area shall be dug out to a sufficient depth to permit the required repairs. All excess material, including pavement, shall be disposed of as surplus material in accordance with Section 303 – Earthwork.

    c. Backfill materials shall be in accordance with VDOT Road and Bridge Standards.

    d. The surfacing needed to cover the exposed area (concrete or asphalt) shall conform to the existing pavement. It shall be placed to the same elevation and grade and have a thickness equal to or greater than the existing pavement.

    e. Replacement of pavement not satisfactorily performed by the Contractor shall be reworked at no expense to the Owner.

2. In Unpaved Areas:

    a. Only necessary excavation around manhole shall be performed.

    b. Backfill shall be replaced and compacted to prevent settlement and to restore the setting to a condition equal to or better than that found in accordance with Section 303 - Earthwork. Backfill shall not cover the manhole.

    c. Any private property which is removed for access to the manhole shall be replaced by the Contractor in existing or better

condition. If this replacement is not to the satisfaction of the Owner, it shall be redone at no cost to the Owner.

3. The Contractor shall take all necessary precautions to prevent falling debris from damaging the manhole trough and/or entering the sewer. The damaged or deteriorated portions of the existing manhole chimney and corbel shall be removed and property disposed of by the Contractor.

4. The chimney and corbel shall be repaired or rebuilt with new brick or precast concrete grade rings as appropriate to reconstruct the chimney to the height needed for the frame and cover to meet the required grade. The manhole frame shall be sealed using either a manufactured or applied sealing method.

2.6 MANHOLE FRAME SEALING

The manhole frame and the chimney above the cone shall be sealed in accordance with the manufacturer's recommendations. Refer to the Contract Documents details for additional requirements.

2.7 FINAL ACCEPTANCE

After the various types of rehabilitation work have been completed, the work shall be visually inspected for compliance and tested for watertightness in accordance with paragraph 2.3 by the Contractor in the presence of the Owner. The Owner reserves the right to inspect the rehabilitated manholes during the warranty period. Any leakage or defects in the work found by this inspection shall be corrected by the Contractor within 30 days from notice, at no additional cost to the Owner.

End of Section

OPERATION AND MAINTENANCE MANUALS

1. GENERAL

1.1 DESCRIPTION OF WORK

Furnish to the OWNER (XX) hard copies and (XX) electronic copies on CD-ROM of an Operation and Maintenance Manual for all equipment and associated control systems furnished and installed.

1.2 QUALITY ASSURANCE

In addition to the requirements herein, Operation and Maintenance Manuals shall conform to the requirements of the Virginia Department of Health where applicable.

1.3 SUBMITTALS

A. Prior to the Work Reaching 80 percent completion, submit to the OWNER for approval two hard copies of the manual with all specified material. Within 30 days after the OWNER's approval of the two-copy submittal, furnish to the OWNER the remaining (XX) hard copies of the manual. Provide space in the manual for additional material. Submit any missing material for the manual prior to requesting certification of substantial completion.

B. After approval of the hard copy manuals, submit with the remaining hard copies, (XX) electronic copies on CD-ROM organized in the same manner as the hard copy manual. All files shall be in AutoCad (.dwg), Adobe Acrobat (.pdf), or any Microsoft Office product.

1.4 FORMAT AND CONTENTS

Prepare and arrange each copy of the manual as follows:

1. One copy of an equipment data summary (see attached sample form) for each item of equipment.

2. One copy of an equipment preventive maintenance data summary (see attached sample form) for each item of equipment.

3. One copy of the manufacturer's operating and maintenance instructions. Operating instructions include equipment start-up, normal operation, shutdown, emergency operation and troubleshooting. Maintenance instructions include equipment installation, calibration and adjustment,

preventive and repair maintenance, lubrication, troubleshooting, parts list and recommended spare parts.

4. List of electrical relay settings and control and alarm contact settings.

5. Electrical interconnection wiring diagram for equipment furnished including all control and lighting systems.

6. One valve schedule giving valve number, location, fluid, and fluid destination for each valve installed. Group all valves in same piping systems together in the schedule. Obtain a sample of the valve numbering system from the OWNER.

7. Furnish all O&M Manual material on 8-1/2 by 11 commercially printed or typed forms or an acceptable alternative format.

8. Provide space for a reduced set of record Contract Drawings, size approximately 11 by 17 inches and folded to 8-1/2 by 11 inches. Drawings will be furnished by the OWNER.

B. Organize each manual into sections paralleling the equipment specifications. Identify each section using heavy section dividers with reinforced holes and numbered plastic index tabs. Use 3-ring, hard-back binders Type AVE-87784 as manufactured by Avery Dennison, or equal. Punch all loose data for binding. Arrange composition and printing so that punching does not obliterate any data. Print on the cover and binding edge of each manual the project title, and manual title, as furnished and approved by the OWNER.

C. Leave all operating and maintenance material that comes bound by the equipment manufacturer in its original bound state. Cross-reference the appropriate sections of the CONTRACTOR's O&M manual to the manufacturers' bound manuals.

D. Label binders Volume 1, 2, and so on, where more than one binder is required. Include the table of contents for the entire set, identified by volume number, in each binder.

END OF SECTION

City of Norfolk Department of Utilities

Project XX

Equipment Data Summary

Equipment Name: Specification Reference:

Manufacturer:

Name:

Address:

Telephone:

Number Supplied: Location/Service:

Model No: Serial No:

Type:

Size/Speed/Capacity/Range (as applicable):

Power Requirement (Phase/Volts/Hertz):

Local Representative:

Name:

Address:

Telephone:

NOTES:

City of Norfolk Department of Utilities

Project XX

Preventive Maintenance Summary

Equipment Name: Location:

Manufacturer:

Name:

Address:

Telephone:

Model No: Serial No:

Maintenance Task	Lubricant/Part	D W M Q SA A	O&M Manual Reference

NOTES:

*D-Daily W-Weekly M-Monthly Q-Quarterly SA-Semi-Annual A-Annual